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[illegible]**AVIATION'S 1945 YEARBOOK**

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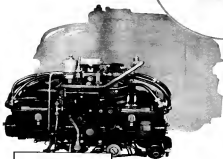
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Scintilla "sparks" the finest

- FRANKLIN AIRCOOLED
- KIMBER
- CONTINENTAL
- JACOBS
- LAMIRANCE
- LIFCONING
- PRATT & WHITNEY
- RANGER
- PACCAARD
- WARNER
- WRIGHT



Lawrence  
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"Working Power" teamed  
with "Fighting Power"

On Mars bombers, Navy aircraft  
and blimps vital working power is supplied by Lawrence  
Aviaelectric Power Plants, using Scintilla Aircraft Ignition  
equipment to help deliver the vital spark.

**Bendix**

AVIATION CORPORATION  
CHRYSLER, N. Y.

AVIATION, February, 1945

For the 12th straight year the editors  
are proud to present their biggest special  
issue—the Yearbook. A total  
of 115 American types are presented in  
appearing three-view, photographs  
and so on. This section includes 17  
chapters now in design, twelve even  
under construction or flying. Altogether 280  
different American, Allied, and enemy  
types are portrayed, including 25 of  
the top's newest, many of which are  
detailed and described publicly for the  
first time. And again AVIATION pre-  
sents its aircraft and engine specifica-  
tion tables, a job unattempted in the  
entire publishing field. This year  
the tables include the first specifica-  
tion tables ever published on heli-  
copters, and the most comprehensive  
to yet come on jet planes. The Year-  
book starts on page 119 with a special  
table of contents for the section, which  
includes 18 pages of AVIATION's  
Yearbook of Design Detail.

In its editor's preface points out in in-  
cidental, these are most important  
signs for the aircraft industry and the  
land of America, for it is now that  
action policies must be established  
which, as one is better fitted than  
any Wilson, president of the Aero  
Club and vice-chairman of United  
Aircraft Corp., to analyze the problems  
being the industry and the country.  
On page 110 he presents graphically  
five components for a national re-  
sponse, that might well generate the  
confidence for a lasting peace.

Where and how to sell airplanes—and  
everything that goes with airplanes—  
presents plenty of problems for all  
concerned. Biggest of the problems,  
of course, is knowing the competitors.  
The financial editor supplies some of  
the answers in the second part of his  
valuable series; this month's article  
ends on page 186.

The most of propaganda and confu-  
sion reports about the Navy's V-1 rocket  
bomb seem to have convinced the pub-  
lic body so much so that it's well  
nigh impossible to tell whether it is  
only a potent weapon or just a topic  
for the Navy's mouthpiece. We  
start with the Navy, which has a steady  
reputation for many years, to  
capture the thing, not only as a wonder-  
ful of our best as a phase of aero-  
nautics. You'll find "Evaluating the  
V-1" beginning reading; it  
begins on page 252.

We're particularly pleased with a new

## Briefing for February



MAJ. GEN. KENNETH A. WOLFE, who leads  
ATC's Engineering & Procurement Division,  
is one man who really knows the value of get-  
ting and staying out of debt with tech-  
nological developments, for he was the 20th  
Ranker Command's first "head man." On  
the basis of long experience in the develop-  
ment of aircraft, Gen. Wolfe tells us on page  
113 why "We Must Retain Techno-  
logical Supremacy" (ATC photo).

series which leads our Maintenance  
Section this month, for it's of value to  
personal plane owners, land-based op-  
erators—anyone who wants to get max-  
imum efficiency from his aircraft. The  
complete series will be a valuable  
handbook on engine trouble-shooting  
and overhaul, and that'll be good for  
years, because it gets down to prac-  
tice. AT Landover, who did the  
series, has achieved big and little suc-  
cesses.

comes all over this country—and other  
places too—and speaks from experi-  
ence. Since he's one of those men  
who's really interested in engines, he  
writes about them in a thoroughly in-  
teresting way. "What Makes Expert  
Mechanics Happy?" starts on page  
258.

Another addition to the Illustrations  
on comprehensibility in aviation our features  
this month—in Aviation's For Better  
Design Section, beginning on page  
253. Three years'll find a discussion of  
the design, construction, and high reli-  
ability value of the recovery (air) flap now  
going on Republic P-47 Thunderbolts.



Twelve P-47s specially built for tests, in-  
demonstrated for Aviation's Ed Wolfe (see  
last Feb. Pilot Pub. Column). Reported Ed  
Wolfe.

### Down the Years in AVIATION'S Log

25 Yr. Ago (1920)—First Paris  
Aeronautical Exposition opens. . .  
Post Office requests \$50,000,000 for air-  
mail routes. Chicago-Salt Lake, Philadel-  
phia-Pittsburgh-Kansas City-N. Y.-C.  
Washington-St. Louis, Minneapolis-  
Chicago-St. Louis. . . Curtiss, Amer-  
son, and Boeing fly the 11 flying  
boats, valued at \$50,000. Chase for  
French air service looking Hong Kong,  
Manila, and Philippines. . . Zeppelin  
bombs 4-engine 150-ft-span composite  
flying boat. . . Germany's LZ 129  
bombs 200,000 lb. . . Navy breaking  
altitude record. . . Army holds 20-  
cyl., 600-hp., water-cooled liquid cool-  
ing engine. . . Navy asks \$335,000  
for building two seaplanes, twice size  
of any in existence. . . Congress bans  
export of helium.

18 Yr. Ago (1927)—Bertram Miles  
1,000-hp. monoplane 210 mph at Ros-  
tation. . . San Francisco plane 24-  
000,000 sq. ft. . . Mitchell Field re-

commence with directional radio. . .  
Delta cuts air rates 30 percent. . .  
Flying Air Transport opens new com-  
mercial headquarters at Cleveland, Ohio.  
NAT and EAT cut flight rates  
and horizon instrument in service.  
N. Y. C. police department forbids  
private aircraft pickup from sky-  
scraper and Radio engineer  
after aviation. . . France proposes  
grant of \$12,000,000 for military and  
naval aviation.

10 Yr. Ago (1935)—ECC recom-  
mends revision of standard rates. . .  
Navy orders 35 amphibious from  
Chance Vought. . . Amelia Earhart  
flies solo from Honolulu to Oakland.  
All American Air Races held at  
Miami. . . Max Doellittle flies two  
passengers coast-to-coast in 11 hr. 50  
min. . . France's Raymond Delpy  
flies Caudron-Renard at 214 mph.  
Lt.-Col. Andrew Jones com-  
mander of GIBQ Air Force.



True Air Speed



**SIMPLIFIED AIR NAVIGATION**, through the correct and continuous indication of True Air Speed, is the latest result of Kollsman's development progress. The new True Air Speed Indicator—a combination Airspeed, Altimeter and Thermometer in one interacting assembly—eliminates the separate reading of these instruments and the involved calculations formerly required, yet gives a direct reading more accurate than can be computed. By ridding long-range air navigation of this source of error, Kollsman makes another important contribution to future aviation progress.

**KOLLSMAN AIRCRAFT INSTRUMENTS**

PRODUCT OF

**SQUARE D COMPANY**

MINNETONKA, MINN.

EMERYVILLE, CALIF.



#### PIPER PLANE QUIZ

- How long does it take to learn to fly a Piper Cub?
- It is traveling to a Piper Cub airport?
- Will someone Piper Cub to add on the instrument panel?

This lesson and others that will follow include only the fundamentals. See your Piper Cub dealer for actual flying instruction. Write to "Piper Quiz" questions you want answered.

PIPER AIRCRAFT CORPORATION • LOCK HAVEN, PENNA.

**PIPER CUB**

Points the Way to Wings for ALL Americans

# GOODYEAR AIRCRAFT PRODUCTION REPORT

## CONTRACT: W33-058-ACIO9 BOEING B-29 (Superfortress)

750 SETS: FORE AND AFT BOMB BAY SECTIONS,  
WING CAP SECTIONS, EMPENNAGES

INITIAL CONTRACT RECEIVED: AUGUST 1943  
FIRST PRODUCTION UNIT DELIVERED: MARCH 1946  
100TH PRODUCTION UNIT DELIVERED: NOVEMBER 1946

REMARKS: Conversion to B-29 production was effected without interrupting completion of B-24 contract in same plant. Although change-over involved building more than 8,000 tools and schooling of hundreds of employees in B-29 processing, first units were delivered full month ahead of schedule. Orders for 50 modifications in original design led to Goodyear's development of "quick-fix" method of making these changes without stopping production line—an achievement that is speeding deliveries of these essential components.

Goodyear is building components for 16 different Army Navy types of aircraft, including complete Corsair fighters and bombers.

## HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE

1. By constructing major components to manufacturers' specifications.
2. By designing parts for all types of airplanes.
3. By re-engineering parts for quantity production.
4. By building complete airplanes and airships.

## AIRCRAFT INDUSTRY

5. By extending facilities of Goodyear Research Laboratories to aid the solution of any design or engineering problem.



GOODYEAR AIRCRAFT CORPORATION  
Akron, Ohio • Wickliffe Park, Akron



# FIRST CHOICE ON THE SKYWAYS

— for safety and dependability !



CHANNEL TREAD

Overlaid  
All-Weather  
Tread

All-Weather  
Tread

WET TREAD

HERE you see a partial line-up of Goodyear's service-proved line of airplane tires — a line that includes a wide variety of types and tread designs in a range of sizes to fit all ships, from light trainers and helicopters to the largest superboomers built today.

As pioneer of the modern low-pressure airplane tire, Goodyear has steadfastly maintained a wide margin of leadership in the quality and durability of its tires. That is evidenced by the high preference they enjoy in all military, commercial and civilian operations.

Today Goodyear airplane tires are built with rayon or

nylon cord construction...depending upon landing speed and load requirements. Extra reinforcing breaker strips give added protection against impact stresses and braking. High-tensile steel-wire beads insure firm anchoring on the rim when landing and braking.

As a result Goodyears give longer service, without many extra hours of polishing. Full-braking stops on paved, gravel, coral or rough-ground runways. Our engineers will be glad to assist you in selecting the correct type of tire for your airplane. Write: Goodyear, Aeronautics Department, Akron 16, Ohio or Los Angeles 54, California.



## THE BEST TIRES DESERVE THE BEST TIRES

Only Goodyear airplane tires, too, to get the most out of your tires. The Goodyear Standard Tire is designed for maximum wear under heavy loads and severe braking. The Goodyear Patterned Tire will handle most conditions even those most severe, wet, or uneven so smooth. The Goodyear Dual Tire provides against the usual hazards from blowouts and punctures in emergency cases.

*Manufacturers, Airline Operators and  
Private Flyers depend on GOODYEAR for—*

- TUBES • TUBES & WHEELS • BRAKES • AIRCRAFT NOSE • HYDRAULIC HOSE • HYDRAULIC PACKING
- DISKETS • CAPACITORS • WHEELS • GRIPPER • LIFE RAFTS • DUCTS • CHANDLER SHEETS • RUBBER
- LIQUID RUBBERS • GLASS RUBBER PARTS • FUEL AND OIL CELLS • RUBBERIZED FABRIC • ENGINE MOUNTS
- AIRCRAFT CUSHIONING • FLYING • FLYING • FLYING • FLYING • FLYING • FLYING • FLYING
- RUBBER PRODUCTS • RUBBER PRODUCTS • RUBBER PRODUCTS • RUBBER PRODUCTS

GOODYEAR RESEARCH LABORATORY



RUBBER SERVICE HEADQUARTERS

# GOODYEAR

# Background of LEADERSHIP



*Eclipse* AVIATION ACCESSORIES  
Eclipse Pioneer Division • Telephone: N. 2 • Los Angeles 24, Calif.

ECLIPSE  
ENGINEERS

**Bendix**  
AVIATION CORPORATION

# What are "A-Q" Gears?

"A-Q" is a symbol for aircraft quality. Gears so designated represent a new development in power transmission. They must have extremely light sections and carry loads far in excess of values customarily considered safe design. They must operate at pitch line velocities that can be measured in miles per minute.

## How Are Such Gears Produced?

Producing "A-Q" gears demands covered of material at every stage of production from billet to finished blank. It demands extraordinary care in heat treatment so that each gear is of the proper hardness at the tooth and at the core. It means holding every dimension to close tolerances and watching tolerances to prevent excessive multiplied error.

To achieve the extreme accuracy demanded in "A-Q" gear production, Foote Bros. have developed new manufacturing techniques—revolutionary equipment.

## Why Were They Developed?

The instant demand of war for aircraft engines of tremendous horsepower produced by the thousands posed a serious problem in the development of gears for these engines. Engine manufacturers required gears directly approximating engineering perfection—and, furthermore, demanded that these gears be produced by the hundreds of thousands. By applying the "know-how" acquired in three-quarters of a century of gear manufacturing, Foote Bros. met the need for these new gears.

## How Can They Be Applied to Peacetime Products?

"A-Q" gears offer many distinct advantages to the manufacturer of tomorrow's peacetime machines. They assure greater mechanical efficiency—a reduction in weight—greater speed—less noise—greater compactness—and a more economical transmission of power.

FOOTE BROS. GEAR AND MACHINE CORPORATION  
Department Q, 5125 E. Western Blvd. • Chicago 8, Illinois

"A-Q" Stands for Aircraft Quality

# FOOTE BROS.

Better Power Transmission Through Better Gears

This information product requires no return to "A-Q" gear specialists. It is a new and revolutionary type of precision gear. A copy will be sent you on request as soon as it is ready.

# for Victory!

ROAT

PLANES

THAT

SERVE

THE

UNITED

NATIONS

400 AIRCRAFT CORPORATION, 402 SECOND STREET, ORANGE POINT, N.Y., U.S.A.

AVIATION, February, 1943

# Here's your 3-step plan for **BETTER TOOLS TO CUT PRODUCTION COSTS!**

Use this sure way to knock the props from under production costs. Let Carpenter help you put this three-step plan to work in your tool room and heat treating department. With it you can reduce machine down-time and actually lower unit costs.

## 1. Cut The Cost Of Tooling-Up And Reduce Machine Shut-Downs!

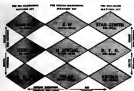
It's so trick at all to make sure of selecting the proper tool steel for each job when you use the Carpenter Matched Set Method. Many plants use this method of selection to lock production problems caused by prototype tool and die failures. And it works! New tool makers who have used it are relying on it to get away job done right. They know it cuts the cost of tooling-up and reduces machine shutdown time. And those savings are bound to show up in the cost of the finished product.

## 2. Insurance That Each Tool Will Pay-Off On The Job!

As you know, proper heat treatment is the second step to seeing that each tool is able to do its job right. And the Carpenter Steel Treating Guide quickly gives you this important information about each Carpenter Matched Tool Steel. Type analysis, Tempering heat, Hardening heat, Annealing treatment, Hardening treatment and Recommended drawing ranges. And this guide sheet gives you tips on quenching, oxidizing atmosphere, finishing time and heating speed in drawing. For your copy, drop us a note on your company letterhead.

## 3. Check On Tool Life And Output Per Grid!

Find out which tools and dies need too frequent retooling or fail prematurely in service. Carpenter Matched Tool Steels can help you lock this condition, and reduce unit costs. And for personal help in your tool room or heat treating department, get in touch with your nearby Carpenter representative. He knows tool steel inside-out, and can also provide the kind of engineering help that helps tough production bugs.



## How The Carpenter Matched Set Method Helps To Solve Your Tool Steel Problems

There are really Matched Tool Steels, as one picks up its job where the other "leaves off."

The key steel is the one in the center, No. 11 Special, a straight carbon, tough texture, water-hardening tool steel. When you have a tool to make, you first find out if it can be made from No. 11 Special. If the answer is "Yes", you go no further. But when the answer is "No", you use the diagram to point the way to the tool steel that will do the job. For greater wear resistance, you go north. For greater hardening accuracy and

safety, you move west. Just follow the diagram.

To learn more about the ways this method can be used in solving your special problems, ask for a copy of the 167-page Carpenter Matched Tool Steel Manual. It contains an 80-page tool uses and steel selector that many tool engineers find extremely handy. For your copy, write us a note on your company letterhead, indicating your title. (Free to tool steel users in U.S.A.)

## RESULTS that show how the Carpenter Matched Set Method can boost plant output and cut costs all along the line!

### A STAKING PUNCH



only lasted about 40 hours until this method pointed the way to the proper Carpenter Matched Tool Steel for the job. With No. 11 Special, punch life jumped from 40 hours to over 2 months of service.

### A SHAVING DIE



lasted over 99,600 pieces were produced as it wore too rapidly. Then this method indicated Sintered for maximum wear resistance and heat-treating accuracy. Production per punch—over 900%!.

### COINING PUNCHES



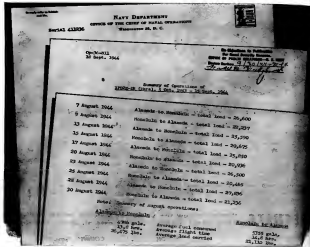
for forming bearing races from 1218 steel lasted after running a half-day. The Diagram pointed to the greater toughness of Sintered. Result: 200% more production per punch—and 40 fewer tools to make work smooth.

THE CARPENTER STEEL COMPANY • 128 W. BERN STREET • READING, PA.



**Carpenter MATCHED TOOL STEELS**

175 Broadway, New York 6, N.Y. • 10006  
Cincinnati, N.Y. • 10006



## Official Navy Records Show . . .

## The Martin Mars Means Ease of Maintenance!

TAKE a look at the above Navy release and you'll see why we say the Martin Mars means ease of maintenance. Only one page of the release is shown, detailing operations for August 1944. Between the 7th and the 30th of that month the Mars made 10 trips between Hawaii and the Mainland. Since then she has steadily stepped up performance and in November completed 14 flights between Hawaii and California, flying a total of 33,000 miles and carry-

ing more than 300,000 pounds of cargo. Her current utilization is 9.7 hours per day. This high availability of Mars flying boats will pay substantial dividends to postwar airline operations. Less time for overhaul means more time in profitable operation. This savings, along with essentially low ten-mile costs and the fact that war's end will find Mars assembly lines cooled and geared for postwar delivery as a minimum purchase price, all con-

tribute to make the most economical overwater aircraft yet built. Companies interested in detailed performance data on the Mars, write THE GLENN L. MARTIN COMPANY, BALTIMORE 3, Md.



**Socony-Vacuum Announces**

# GREAT NEW TRANSPARENT CUTTING OILS!

ANTICIPATING current needs, Socony-Vacuum has developed, and is now announcing, a great new line of light-colored, transparent, machine cutting oils.

These oils, the New S/V Subbase, have already proved their superiority in extensive field tests, and are now in service.

In addition to better visibility of the work, and no odor to cling to

operator's clothing, the new oils also provide: outstanding lubricity; less sensitivity to changes in the hardness and structure of metals; improved drainability; and better all-around performance for longer tool life and improved finish.

All of these improvements have been added without sacrificing anti-weld and pressure resistance characteristics. The New S/V Subbase are

available now for your cutting operations. Ask your Socony-Vacuum representative for details.

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Standard Oil of N. Y. Div. • White Star Div. • Lubrizol Div. • Chicago Div. • White Eagle Div. • Wellman Div. • Magnolia Petroleum Co. • General Petroleum Corporation of California.

CALL IN SOCONY-VACUUM FOR "CORRECT LUBRICATION"



Socony-Vacuum's FIVE STEPS to Lower Production Costs for You

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Connect
5. Progress Reports of Results Secured

For Aircraft  
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Constant testing in the air or on the ground... is possible with Federal's regulated-voltage power supply.

Designed to replace unwieldy storage batteries normally used for this purpose, this light-weight Federal power supply converts 115-volt alternating current into a closely regulated, filtered direct current for the accurate testing of electrical instruments and other aircraft accessories.

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*Federal Telephone and Radio Corporation*



Newark 1, N. J.

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CORROSION

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SPARK  
INTERFERENCE

SHOCK

VIBRATION



**RADIO SHIELDED IGNITION ASSEMBLIES**  
Geared to the Grind of Modern Combat

**BOLTON MANUFACTURING CORP., WEST HAVEN, CONN.**

**IF** lengthy conferences and heavy thinking precede final equipment specification....

**DON'T MAKE A BLINDFOLD CHOICE**

## OF VITAL CONNECTORS

It's human to take the "little things" for granted. Yet, a goodly percentage of the electrical troubles... in your plant, or in your products in your customer's plant... are due to nothing more than poor connections. Check with your maintenance or service men on this point. Then you will agree that more attention should be given to electrical connections.

Plant interruptions and electrical outages cost real money. And when competition again gangs up on you, your dealers and customers will expect the same high standards in connectors as in the other components you "build in."

Yes, electrical connectors are important... sufficiently so that you should insist that the connectors you use remain efficient, and trouble-free, in service. The kind that go on quick, and stay on fast; that withstand corrosion, temperatures, vibration, or shock. The kind that are available... in all sizes and for all purposes... here at Burndy. Let us send you our latest catalog.

Burndy Engineering Co., 187A Bruckner Blvd., New York 54, N. Y.



**Burndy**  
Sustainer for CONNECTORS  
In Canada  
Canadian Wire Materials, Limited, Toronto 11



## Now the **WHOLE** doughnut goes to work

Whenever there's danger of leakage of gas or liquid around a rotating shaft, there's need for a Sylphon Shaft Seal. Principles successfully applied to control problems for more than 40 years, have proved eye openers in this special field.

Basically, the application is very simple; a sturdy helical spring holds center ring or seal nose firmly against a sealing surface mounted at the end of a shaft. A Sylphon bellows provides a flexible, gas- and liquid-tight connection between a rotating flange and the seal nose.

Sylphon Shaft Seals are engineered for each specific application. Sizes range from inch for dry environment shafts to multi for huge refinery installations. Finely machined and balanced, they afford a perfect seal against pressures up to hundreds of pounds, operate at shaft speeds up to 400 RPM.



Sylphon Shaft Seal. Prevents leakage around a rotating shaft where the shaft extends from inside to the outside of enclosure.

**New Model—"The Story of Metal Bellows"** is available to interested engineers and organizations.

Write for Bulletin CA-634, giving as much specific information as possible about your problem.

**FULTON SYLPHON**



## Our engineers don't understand each other

We keep our engineers separated by 2500 miles. And for good reason. One group consists of hot shots on hydraulics, the other on electronics. They don't even speak the same language. Several thousand employees are separated for approximately the same reason.

Our brilliant executives, however, can talk out of both sides of their mouths... Electronics and Hydraulics. But when the going gets tough, they invariably call for our engineers, because the stuff we make is so precise and technical nobody but electronic or hydraulic engineers can actually understand it.

Your engineers and ours should get together. They'd talk the same language. And our factories can translate their conversation into what you want.

# Aireon

MANUFACTURING CORPORATION

Formerly AIRCRAFT ACCESSORIES CORPORATION

Radios and Electronics • Engineered Parts Control

NEW YORK • CHICAGO • KANSAS CITY • BURGESS

ATTENTION: Engineering



## DON'T LET THE WAR METHOD KILL POST WAR PROSPERITY

### HERE'S HOW WALKER-TURNER MACHINE-TOOLS CUT COSTS!



200-5100 R.P.M. 50-5300 S.F.M. 100-5300 R.P.M.

Wide range of operating speeds enables you to select the optimum cutting speed for any material.



Walker-Turner machine tools have been built to operate on hydraulic and electric power. This Walker-Turner 50" Drill Press is built for both hydraulic and electric power. It is built for both hydraulic and electric power.



Low price does not mean low quality. Walker-Turner machine tools are built to last.

This Walker-Turner 50" Drill Press is built for both hydraulic and electric power. It is built for both hydraulic and electric power.

WALKER-TURNER COMPANY, Inc.  
Patented New Jersey



# MACHINE TOOLS

ATTENTION: Engineering





In meeting  
the challenge of the future,  
*Western Electric*  
equipment leads the way

War's end will bring a challenge to everyone. To those identified with communications and transportation, faster, better interchange of ideas and goods will be the order of the day.

We at Western Electric—with our 25-year heritage of leadership in communications equipment—believe we are peculiarly qualified to accept this challenge.

In world-wide telephony, broadcasting, aviation, marine and mobile radio—in every field where sound-transmission apparatus plays a part—Western Electric has led and will continue to lead the way. In these fields as well as in television, Western Electric will play a dominant part in the future.

To speed Victory, buy more War Bonds—and keep them!



*Speed up Reconversion*  
with

# FEDERAL BALL BEARINGS

INDUSTRIAL • AUTOMOTIVE  
AIRCRAFT • MARINE



THE FEDERAL BEARINGS CO., INC.

*Makers of Fine Ball Bearings*

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# LIFE BLOOD

## for Aircraft Controls

Several important types of Whiz Hydraulic Fluids are manufactured by R. M. Hollingshead Corporation, a major supplier for Army and Navy aircraft. Of these fluids, two types are currently in great demand. Both conform fully to Government specifications and each is supplied in two grades.

★

Your inquiries about these hydraulic fluids will receive prompt attention. Our engineers will gladly work directly with yours in designing special chemical products to meet unusual requirements. R. M. Hollingshead Corporation, Camden, N. J. or Toronto, Canada.

**Hollingshead**  
LEADER IN  
MAINTENANCE PRODUCTS



Also makers of Whiz Bon-Pore  
Fire Compounds, Compressed  
Emulsions, Lubricating Oils, and  
Cleaning Compounds for Aircraft

TYPE AND GRADE	TYPE AND GRADE
HYDRAULIC FLUID Type A Type B	HYDRAULIC FLUID Type C Type D
INDICATED USES	INDICATED USES
CHARACTERISTICS	CHARACTERISTICS

BUY MORE BONDS

AVIATION, February 1945



**PLANNED INSTALLATIONS LIKE THIS**  
**MAKE FASTER, FINER FINISHING A CERTAINTY**

Completely Coordinated  
Finishing Systems  
Engineered to Your  
Plant and Product

Here is a typical example of what proper planning can accomplish in coordinating the various processes of finishing into a compact, smoothly-operating system that conserves both time and manpower — and does a better job. This installation was specifically designed to handle the complete finishing of aircraft engine parts. But—wherever the product to be processed—regardless of nature, size or shape—Mahon engineers can be of material assistance in planning and producing the precise equipment you may need to put YOUR production on a fast-moving, highly efficient and economical basis.

Designers and Manufacturers of Metal Cleaning Machines, Rust Proofing Machines, Hydr-Fiber Spray Booths, Ovens of All Types, Filtered Air Supply Systems, Vapor-Phase Rust Collectors — and Many Other Units of Special Production Equipment — Including Complete Finishing Systems.

**THE R. C. MAHON COMPANY**  
DETROIT 11 CHICAGO 4



**Designed and Engineered for  
Rapid, Positive Clamping, Maximum Open Clearance**

**DANLY  
Kwik-Klamp  
TOGGLE CLAMPS**

**To Speed Assembly, Machining Operations, Metal and Plastic Stamping.**

**For complete data, including tested pressure figures, send for the new Kwik Klamp Catalog.**

**DANLY MACHINE SPECIALTIES, INC.**  
3100 South 32nd Avenue Chicago 16, Illinois



## A quiet advertisement for a noise-weary World —the Rotameter and its advantages to you for flow rate measurement and control

What all the noise in the World today, perhaps you will appreciate advancements of a more quiet sort. So we make this simple way of telling you about our product. We make rotameters for flow rate measurement and control, and we believe it is important that you know about them because they offer advantages which you cannot obtain in any other flow rate measuring device. First, let us describe the principle of the rotameter.

### The Principle of the Rotameter



The rotameter is an "area type" meter in which the variation in area is provided by means of a vertical tapered tube with the small diameter at the bottom. A weight of fixed diameter (called the "float") moves freely within this tapered tube and hence the area between the float and tube decreases as the float rises. This area then becomes a measure of the flow and the weight flow rate there at a fixed position of the float in the tube. Therefore, the rotameter can accurately calibrate to read directly in flow rate. This method of flow measurement gives advantages of great importance.

### The Advantages of the Rotameter

Simply stated, the main advantages of our rotameter are as follows:

- 1) Since the moving tube is usually transparent, the main measuring elements (float and tube) and the fluid being measured are clearly visible. High accuracy may be maintained because the fluid accumulates are continuously present and become a steady stream reading instrument, which read, may be quickly checked against the primary measuring element, the rotameter.
- 2) Only flow range may be obtained in one instrument. A range of flow from maximum to minimum flow usually need a change of instrument.
- 3) Since scale variation is measured (rather than fixed), the calibration curve of the rotameter is precisely a straight line so that a direct reading scale with evenly spaced divisions is obtained. There is no compression of the divisions at low flows, as the same high measuring accuracy is gained throughout the flow range.
- 4) Because the area between the float and tube increases when the flow rate, the pressure drop across the float is low and the pressure drop may be reduced and flow control head may be reduced by using an orifice meter with a light float.
- 5) Our patented fluid measurement compensates for normal variations in viscosity and density so that viscous oils and chemicals, such as concentrated sulphuric acid, may be measured accurately in spite of wide temperature changes.
- 6) The moving float works a distance of at least 5 inches, and measures an observable width that travel as long as 24 inches. Hence, by starting up the flow range and lengthening the float travel, higher accuracy may be obtained with the instrument that with any other flow rate measuring device.
- 7) The float moves freely in the measuring tube so there is no friction or binding. Therefore, the rotameter reaches the zero position of the scale with a great deal of high accuracy, immediately maintaining flow rate of service.
- 8) Due to its simplicity, the rotameter is readily made oversize proof and, therefore, may be used on measuring large flows, liquid and gases, that no other meter will handle with consistent accuracy.
- 9) Also, due to its simplicity, the rotameter is easy to install and remove, is portable.

### The Scope of Fischer & Porter Rotameters

We designed the precision-bore tapered rotameter tube of bore-tight glass, and have designed and built a full line of rotameters to solve the varied flow rate problems of industry. We can measure liquid flows from 0.15 cubic centimeters per minute up to 14,000 gallons per minute, and gaseous flows from 3 cubic centimeters per minute up to 16,000 cubic feet per minute. Temperatures to 750° F. and pressures to 20,000 p.s.i. can be provided. Flow indication, flow recording, flow insulation, and automatic flow control are all available so you can design which have been proved by many field installations to be practical, accurate and dividend-paying meters.



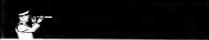
Actually streams of basic improvements in the rotameter have come from our research laboratories. A new most worthwhile development has been a modified bearing system in the electrical induction-bridge method of determining the position of the rotameter float to a remote recording or controlling instrument. This method in the past has been somewhat discredited by Laurence Engineers because it was subject to errors from temperature and voltage variations, and because it lacked power. Because of the great simplicity of the induction-bridge principle, we decided not to accept this criticism, so we went to work to overcome its weakness. Today we can guarantee that our new circuit is not affected by wide variations in ambient temperature and voltage, and furthermore it has shown the power of any previous comparable instrument, so that the pen now points with speed, precision and accuracy. One of our most important recent product announcements for aviation has been a smaller size single meter for gasoline or oil. This instrument has a new electronic circuit that is free of friction and hysteresis. It is also the only light meter that compensates for viscosity and density variations in the fluid being measured. It offers high accuracy in flow rate measurement for post-war planes.

### How to obtain

### "A New Era in Flow Rate Measurement"

We have prepared an interesting booklet entitled, "A New Era in Flow Rate Measurement," which expands the above material from a profusely illustrated, non-technical and instructive manual for those who have flow rate control problems and who would, therefore, like to know more about our rotameters. If you will write to us, we will gladly send you a free copy without any obligation. In the same letter, you can outline one of your most important flow rate problems, we'll tackle it gladly and try to come up with a good answer for you.

**FISCHER & PORTER COMPANY**  
362 COUNTY LINE ROAD • HAYBORO-PA.



**It is reported that . . . . .**

Through recent experiments our know reserves of bauxite (source of aluminum) have been increased by more than 100 million tons. *Science News Letter.*

get ready with GONE for tomorrow

The National Postwar Products Exposition is scheduled to open March first at the Chicago Coliseum. *Marion W. Brown, Jr. Mgr. 1619 S. Wabash Ave., Chicago 6.*

get ready with GONE for tomorrow

A new tractor-drawn farm implement plows, discs and harrows in one operation. "Full-Master," Full-Master Mfg. Co., Portland, Oregon.

get ready with GONE for tomorrow

Today's scientists have revived a four-thousand year old method of killing insect pests with few chemicals. These daisies adhere to the insect's skin or wing and interfere with its water balance. Death results from thirst. *Dr. H. V. A. Brinson, Imperial College, London.*

get ready with GONE for tomorrow

A railroad now has one-hundred plywood box cars and one thousand on order. The weight saving is said to be about two tons per car. *Great Northern Railway.*

get ready with GONE for tomorrow

A new "de-barker" is being used in some pulp mills that removes the bark from logs by the force of a jet of water at 800 pounds pressure without removing any wood. The saving in wood is said to be as high as 25%. *Scientific American, Oct. 1944.*

get ready with GONE for tomorrow

The continuous injection molding of plastics is made possible by a new machine. *Chrysler Corp.*

get ready with GONE for tomorrow

A new electric stove requires no gas but absorbs heat from an electrically heated and thermostatically controlled base. *Electrolux Vacuum Cleaner Co., Detroit.*

Jet propulsion may be used to power sailplanes and gliders and, in miniature, for flying models. *McDonnell-Dugan.*

get ready with GONE for tomorrow

A university engineer has announced the discovery of a new type of concrete, useful for building construction, that is stronger than steel and lighter than aluminum. *Northwestern University.*

get ready with GONE for tomorrow

A new \$1,800, four-room house will come directly off the assembly line on to a truck for delivery. "Wingfoot Homes," Goodyear Tire and Rubber Co.

get ready with GONE for tomorrow

A "slipper" fastening has been developed that is claimed to seal in liquids and gases. *B. F. Goodrich Co.*

It has been stated that the weight of aircraft engines has been reduced about 40% since the beginning of the war. *Aircraft Yearbook 1944.*

get ready with GONE for tomorrow

Manufacturers of the "Joop" plan to sell it to farmers and are reported to have ordered 25,000 bodies for this purpose. *Willes Overland.*

get ready with GONE for tomorrow

A machine has been patented for making barrels out of cardboard for packing butter, flour, sugar, chemicals, fruits, or small parts. *Frank Industries, Akron.*

get ready with GONE for tomorrow

Aviation and electrical engineers are collaborating on an electric drive for aircraft. The will, if practical, permit the location of engines in the fuselage and do away with nacelles in the wings. *Rughes Aircraft Co. and Westinghouse.*

get ready with GONE for tomorrow

One of the country's largest grocery chains is planning to ship fresh fruits and vegetables to its markets by airplane. *A. & P.*



# INACCESSIBLE

... Helicopters will change the language of Transportation

The term "inaccessible" will no longer apply to many remote locations—pasture, for the helicopter, operated by professional pilots, will provide swift, safe transportation and light cargo service to many points heretofore accessible only by pack animals, portage and canoe. To back a trail by muleback through dense trackless tropical jungle, may take months—even to point a machine gun away. The same distances by modern helicopter would be only a matter of minutes. Such service is almost unneeded in its economy and safety as it is swift and safe over dangerous and difficult areas—the steaming "Green Hell" of Matte Grosso, the dense jungle of the Congo and Amazon, the frigid rocky wastes of the ice north— to remote mining camps, trading posts, rubber camps and coffee plantations—the helicopter avoids the hazards and disadvantages of surface transportation.

Yes, in the postwar era, the helicopter should play an important part in helping to develop areas rich in mineral and agricultural resources—heretofore unexploited due to inaccessibility. At McDonnell, in addition to making planes, parts and plastics for war, we're engaged in comprehensive helicopter development work . . . which will make possible, postwar, such dependable transportation to remote points—as costs almost unmatchably low per ton-mile.

**McDONNELL Aircraft Corporation**  
Manufacturers of PLANES • PARTS • PLASTICS • SAINT LOUIS • MEMPHIS •



# Curtis

## SETS THE STANDARD

The "Quality" demanded by Curtis Universal Joint "Standards" gives every user of Curtis joints a product that meets and surpasses rigid and strenuous working needs.

Each part shown has special features—successfully proven in hundreds of applications by airplane and machine tool industries.

Twenty years of experience selecting the right steel, special heat treatments developed by Curtis, careful machining to close tolerances, finished ground surfaces all accessories fitted to give positive, free articulation, are incorporated into each part.

**Figs. 1 & 2 FORKS** — heat treated to secure extreme toughness and strength, made per surface accurately ground for close, smooth working operation, pin holes broached and bored for perfect alignment, the O. D. cylindrical ground for concentricity.

**Fig. 3 CENTER BLOCK** — holes interlocking accurately in the center, with the faces parallel, hardened and precision ground for long wear, web recess for the Telltale Lock ring.

**Figs. 4 & 5 PINS** — hardened and precision ground to close tolerances reduce radial play.

**Fig. 6 GILER** — Curtis ginsseared proper and secured lubrication, and made it easy by furnishing patented side in the large pin.

**Fig. 7 "TELLTALE" LOCK RING** — patented by Curtis — made into small pin grooves and fits recess of center block. This master lock, positive locking of entire assembly — makes disassembly and reassembly quick and easy, and the "Telltale" ring shows at a glance that the ring is in proper locking position.

Curtis Engineers can help solve your universal joint problems. Our experience and knowledge is yours for the asking.

**CURTIS UNIVERSAL JOINT CO. INC.**  
SPRINGFIELD, MASS. • BOSTON GEAR WORKS, NO. QUINCY, MASS., SOLE DISTRIBUTORS

PUSH ON  
SPEED NUT



# JUST A *Push* AND IT LOCKS!

SPEED NUT is started over stud by hand . . .



. . . then pushed down on stud with tool.



Parts are held together with the spring tension lock.

It's just as simple and easy as that! For this unique spring steel fastener needs only to be pushed over rivets, nails, tubing, wire, integral die cast or plastic studs to lock parts firmly together. Threads are unnecessary because the spring prongs of the nut provide a friction lock on even the smoothest of chrome surfaces.

But easy attachment is not the only advantage gained by using Push-On type SPEED NUTS. Costly threaded inserts, drilling and tapping are eliminated — holding costs reduced — assembly speeded

up — and vibration loosening prevented. These fasteners are available in many sizes and shapes . . . rectangular, square, round, or they may be specially designed to fit your particular requirements.

If you want to improve the attachment of name plates, assemblies, wire strips, grilles, or other light-weight parts, write now for samples of Push-On type SPEED NUTS, giving stud diameter and any other pertinent assembly details.

**TINNERMAN PRODUCTS, INC.**

2025 PATTON ROAD, CLEVELAND 12, OHIO  
In Canada: WILSON BROS. CO., Ltd., Hamilton, Ontario  
In England: GERRARD'S, Birmingham, U.K., London



**Speed Nuts**  
THE BASIC PRINCIPLE OF Spring-Tension Lock is Embodied in all Speed Nut Designs

ATLANTIC, February, 1945

# OUT OF PAST EXPERIENCE - PRODUCE A NEW SMALL ACTUATOR



Long before Pearl Harbor, YARD INC. was designing and manufacturing all kinds of actuating equipment for the aircraft industry. Our first units were all hydraulic types.

By 1944, YARD INC. was designing and manufacturing various types of general and mechanically operated actuators for planes of many planes. These aircraft flight control units are operated by hydraulic motors or electric motors.

## THIS IS THE ACTUAL SIZE

Recognizing the need for a small, reliable, torque actuator, we have designed and are building this small power, as shown here in actual size. It weighs 1 lb. The little unit can operate on aerial camera, gun doors or other small doors, trim tabs, remote hydraulic valves. It can be supplied with brake when by adding slightly to length and weight of unit illustrated.

The direct advantage is, this actuator is the fast reliable motor and has patented without other.



**YARD INC.**  
PASADENA 8, CALIF.

New machines of all kinds will be improved  
by the advanced Cast Bronze Bearings  
developed for aircraft engines.  
In precision, finish, and metallurgical uniformity  
Bunting Cast Bronze Bearings, today, surpass  
any bronze bearings ever before produced in volume.

The Bunting Brass & Bronze Company, Toledo 9, Ohio.

Warehouses in principal cities.

BRONZE BEARINGS • BUSHINGS

• PRECISION BRONZE BARS

# Bunting

## Water Injection Corrosion

*Solved by*  
**Romec**



• Corrosion of Water Injection Pumps has been caused by electro-chemical action due to the water solution contacting two dissimilar metals. This has required the development of special internal insulation as well as external contact insulation.

*Write For Illustrated Folder*



### THE ROMECPUMP COMPANY

117 ARBE ROAD • ELTRIA, OHIO • U. S. A.

Manufacturers of FUEL PUMPS—Electric and Engine Driven, TRANSFER PUMPS, Booster Pumps, Tank-Mounted Pumps, Submerged Pumps, VACUUM PUMPS, Pressurizing Pumps, OIL PUMPS, Glycol and Circulating Pumps.



AMERICAN

design...



HERE'S *design* "KNOW-HOW"

EXAMPLES OF SECTION JUNCTIONS AND STRESSING IN MAGNESIUM CASTINGS

Help yourself to more than twenty years of experience in working with magnesium. American Magnesium will gladly share the "know-how" gained through many years of designing, manufacturing, and assembling magnesium parts.

This experience translates itself into better products for you—more efficient designs,

maximum savings in weight. Then, as you place your designs in production, look to American Magnesium for dependable castings, forgings, extruded shapes, and sheet.

May we assist you in employing the weight-saving properties of magnesium to best advantage? Write to Aluminum Company of America, Sales Agent for Mado Magnesium Products, 1713 Gulf Building, Pittsburgh 19, Pennsylvania.

MAGNESIUM **MAZLO** PRODUCTS

AMERICAN

# AIRCRAFT INSTRUMENTS

by GENERAL ELECTRIC

Sixth in a series showing a few of the many Aircraft Instruments that G.E. is building for war and will continue to build in peacetime.

**GENERAL ELECTRIC**  
SCHENECTADY, N.Y.

CHALLENGE  
TO YOUR  
ENGINEERING  
VISION



# MORaine

## POROUS METAL

(COMMONLY KNOWN AS POREX)

In Moraine Porous Metal, designers and engineers have an outstanding new material to work with . . . a material that stimulates the imagination with its wide range of applications. Wherever

product performance can be improved through filtration, separation, diffusion or flow control of fluids, air or gases, Moraine Porous Metal brings new efficiency to the job.

### THESE EXAMPLES SHOULD GIVE YOU A LEAD

**Diesel Engines:** A small Moraine Porous Metal element, fabricated as a cone and bonded to a metal washer, filters the fuel oil as it enters the injector nozzle—safeguarding the orifice against clogging. **Refrigeration Equipment:** Moraine Porous Metal elements separate oil from the refrigerant, and protect control valves, expansion valves and compressor by removing harmful substances. **Pneumatic Tools:** To safeguard fine orifices in pneumatic tools, Moraine Porous Metal

elements filter out harmful dirt. **Lubricated Products of All Types:** Whenever precision parts or polished surfaces must be safeguarded against dirt from lubricating oil, Moraine Porous Metal filters provide effective protection. **Explosion-Resistant Electric Motors:** Where motors must operate in an explosive atmosphere, Moraine Porous Metal vents serve as flame arrestors, permitting the motor to "breathe," yet preventing ignition of the combustible mixture outside them.

BUY AN EXTRA BOND THIS WEEK

MORaine PRODUCTS Division of GENERAL MOTORS

# NORTON

# DIAMOND WHEELS

A NORTH-OUTSTANDING Norton diamond bonded VITRIFIED BONDED DIAMOND WHEELS . . . Combining the fast cutting action of the Norton Refined Bonded Diamond Wheel introduced in 1914 with the long life of the Norton Refined Bonded Diamond Wheel (1937). The Norton Vitrified Bonded Diamond Wheel is available in a range of sizes including the popular 12" x 1/2" and 4" and 6" size breakers—and there's also the Norton Vitrified Bonded Diamond Hand Wheel.

Actual plant tests have proven two to four times greater life while cutting 80% faster.

Another example of Norton research and leadership.

NORTON COMPANY, Worcester 4, Mass.  
Subsidiary, Troy, N. Y., is a Norton Division



NORTON  
DIAMOND  
WHEELS

# Lightweight, Compact, Efficient...that's Fluid Heat Aircraft Heaters

**F**LUID Heat Aircraft Heaters emphasize lightness, compactness, efficiency. Typical of the complete line is model SRH-15, which weighs only 6 pounds 14 ounces, produces 15,000 BTU per hour under flight conditions. Ideal for single and two-place airplanes, it is available with blower for ground operation. Transfer between ground and flight phase is automatic, assuring continuous service.

The same outstanding lightness and compactness feature all models of Fluid Heat's complete line of aircraft heaters. The 100,000 BTU unit weighs but 24½ pounds, measures 9 inches in diameter by 27 inches in length. The 50,000 BTU unit measures 6½ inches by 26 inches, weighs only 16 pounds, 10 ounces. These weights include all controls and accessories. Blowers are available for ground operation, with automatic transfer between flight and ground phases assuring continuous service.

Built around a new heating principle of special advantage in aircraft heating, these super-light heaters employ vapor-entraining combustion process utilizing pre-heated combustion air. The process accomplishes combustion with an unusually low pressure drop, permitting operation at low rpm pressures. It produces a completely suspended fire and therefore gives freedom from lead oxide formation. Fuel retention is so positive that low characteristics are the same under all conditions. Automatic responsiveness assures high combustion efficiency from sea level to ceiling.

Fluid Heat has, for several years, been in the development and manufacture of automatic combustion and heat transfer equipment. These years of heat engineering know-how are built into each light, compact, efficient Fluid Heat Aircraft Heater. You will want Fluid Heat Aircraft Heaters on planes you design, build or equip. Write for full information on this new heating achievement.

**FLUID HEAT DIVISION**  
Anchor Post Fence Co.  
2720 Eastern Ave., Baltimore 24, Md.



**FLUID HEAT'S MODEL SRH-15 HEATER**  
Though it weighs only 6 pounds 14 ounces, complete with all controls and accessories, this heater has a maximum output of 15,000 BTU to flight. Dimensions are 4½ inches by 18½ inches. As for all models, blower is available for ground operation.

**fluid heat**  
AIRCRAFT HEATERS

**WESTINGHOUSE...**  
working partner  
of the aviation industry...



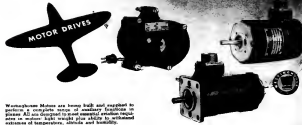
Westinghouse generator, shown in cutaway view, has proven itself established.



Westinghouse Carbon Pole Regulator keeps voltage output of generator constant in spite of generator load and engine speed variations. Used with the Westinghouse Generating Transformer, it provides a high degree of stability and accuracy.



Westinghouse Motors are heavy built and supplied to perform a complete range of auxiliary functions in planes. All are designed to meet essential reliability requirements in motors: light weight plus ability to withstand extremes of temperature, altitude and humidity.



# ...FROM RPM...TO VOLTS...TO RPM

To do electrically the many things required to operate today's planes takes three different major types of electrical equipment. Each is a field of study in itself.

First, a means is needed for changing engine revolutions into electrical energy.

Then, control must be supplied . . . to compensate for changes in load and engine speed . . . to automatically connect or disconnect generators with the power system . . . to transform d-c power to higher or lower voltages for different jobs.

Finally, electrical energy must be converted back from . . . to move wing flaps . . . to retract wheels . . . to light targets.

These are few sources in the world with a firsthand background of experience in all three fields—especially as applied to aviation problems.

Westinghouse is one.

Westinghouse experience in building airplane generators began with the first ever built—wind-driven types to power World War I pioneer aircraft radio.

Dynamotors and control, likewise, date their development with Westinghouse from World War I.

Westinghouse aircraft motors date back to the first applications on the Sikorski and the Akron. Additional applications have come as electrical systems were expanded, beyond the needs of lighting and radio communication.

This leadership continues—and will continue. Important present-day developments . . . high-altitude brakes . . . alternating-current power systems . . . are Westinghouse developments. Others are in progress. Together, they offer sound reasons for making Westinghouse your working partner in aviation progress.

Westinghouse Electric & Manufacturing Company, Lima, Ohio.



*of the aviation industry*



**TODAY...**

**TOMORROW**

**NEW A-C, D-C GENERATOR "PACKAGE"**  
Complete with voltage regulator and relay switch, designed to operate from new a-c systems in planes.

# POWER TO WIN

All Continental Red Seal Engine parts are scientifically coordinated to insure economy and smooth operation.

Continental Red Seal Power — The Power to Win — is the result of an extraordinary ability to produce — an ability that comes from years of skilled experience and the use of modern and efficient manufacturing equipment.

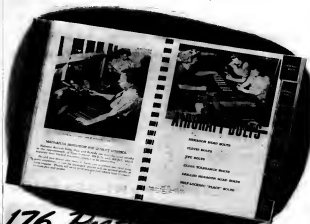
Yield Dollars Are Power, Too!  
Buy War Bonds and Keep Them!

**Continental Motors Corporation**  
Aircraft Engine Division  
MUSKEGON, MICHIGAN



Approved by the National  
and Muskegon Plants of  
Continental Motors  
Corporation for High  
Performance

**Continental**  
*Red Seal*  
**Engines**



**176 PAGES**

**OF AIRCRAFT FASTENERS BY** *National*

Here's a valuable new catalog for the man who is interested in aircraft fasteners . . . the most complete of its kind ever published. It contains complete tables of AN and NAS Bolts, Nuts, Screws, Rivets and other products.

National Aviation Products include many special parts, such as tubular studs, motor mounting bolts, stainless steel instrument screws, brake adjustment screws, gyroscope struts, dome nuts — to name just a few.

An indication of our success in meeting the exacting requirements of the Air Force is the fact that the Air Technical Service Command has designated this company as a "Quality Control Approved Facility".



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**THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.**

# “LUCITE”

**COCKPIT CANOPIES OF**  
**INCREASE VISIBILITY IN P-51 MUSTANG 75%**

**OLD WAY**



**NEW WAY**



**Advantages:** Replaces old-style hood made of eight transparent panels, held together by metal ribs. Eliminates blind spots, provides full vision in all directions in all flying positions. Reduces canopy resistance from 40% to one-tenth. Allows look and feel for many maneuvers and out of pilot. Makes radio equipment accessible instantly.

Colors formed by Shellac Association  
 DuPont, Olefinic, Chloro, for North American  
 Aircraft, Inc., Englewood, Calif.

P-51 Mustang pilots now fly under a protective canopy of transparent Du Pont "Lucite" methyl methacrylate resin. Because of its ability to be heated and formed into streamlined contours, this one-piece enclosure can be shaped by a new vacuum method in less time than was formerly required to produce the old-style canopy. This technique also reduces optical distortion during forming. In addition, the plastic "blendup" reduces riveting operations and operations on alloy sheet stock as well as eliminating the use of machined parts.

"Lucite" possesses remarkable transparency, light weight, tensile strength and is outstanding among plastics for its weather resistance. WPA-allocated, experimental quantities can be obtained for your test purposes.

Address: E. I. du Pont de Nemours & Co., Inc., Plastics Department, Arlington, N. J., or 5801 South Broadway, Los Angeles 2, Calif. In Canada: Canadian Industries, Ltd., Box 10, Montreal.

**DU PONT PLASTICS**

BETTER THINGS FOR BETTER LIVING  
 THROUGH CHEMISTRY



## THE FUTURE BELONGS TO THE Pioneer

Remarkable as the progress in air travel has been to date, important secrets of its future are still half-formed in laboratories or withheld for military security.

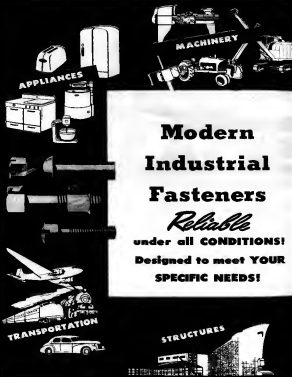
AC first responded to the challenge of aircraft needs in World War I, as the exclusive builder of ceramic plugs for Liberty engines.

Further AC developments of the ceramic type helped to make possible the historic flights of Lindbergh, Muidand, Acosta and Byrd. Still fresh in our minds is the record transcontinental run last April of the transport ship, "Constellation," equipped with improved AC ceramics. And new heights of performance have been reached and maintained by AC ceramic plugs in Army Air Force planes throughout the world.

The record shows that AC "know-how" has kept step with airplane development, continuously pioneering to achieve air travel's goal of utmost reliability.

# SPARK PLUGS

**BUY ANOTHER WAR BOND—  
 THIS MONTH**



**Modern  
Industrial  
Fasteners**  
*Reliable*  
**under all CONDITIONS!**  
**Designed to meet YOUR  
SPECIFIC NEEDS!**

*Special Qualities of Fasteners*  
**that improve products and help  
fabrication**

**UNIFORMLY ACCURATE**

Modern manufacturing methods as employed by fastener makers, produce fasteners in large quantities having the degree of precision in dimensions required for fabrication of structures of all types. Whether your requirements are for extremely close tolerances for precision work, or high grade commercial quality, the products of up-to-date fastener manufacturers today are uniform and dependable.

**HIGH TENSILES**

Carefully selected alloy steels properly heat treated are used by manufacturers to increase tensile strengths for application requiring this property.

**CORROSION RESISTANCE**

Fasteners are made from corrosion-resisting metals, or protected by coatings such as zinc plating, galvanizing, etc., wherever corrosion resistance is required.

**HIGH FATIGUE STRENGTH**

In dynamically stressed studs, high fatigue strength can be obtained by proper design without any weight increase.

**FLUSH HEADS**

Several types of countersunk, recessed, flat and other heads for bolts, cap screws and rivets are standard production with most

manufacturers for use where required for surface smoothness or close fitting parts.

**SPECIAL FINISHES**

In addition to regular ground, machined or polished surfaces, you can get fasteners that are cadmium or chromium plated or otherwise specially finished for appearance, protection or other reasons.

**DUCTILITY**

In many fastening jobs, a certain amount of ductility is desirable, and bolts or rivets providing that property can be obtained according to specification.

**HARDNESS**

This important and useful characteristic is readily obtainable in fasteners through modern hardening methods. The wide variety of materials from which fasteners are made permits a wide range of hardening.

*Useful Data*

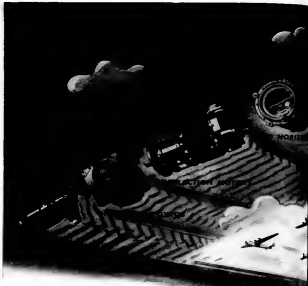
Get in your name on the list to receive, regularly, issues of **FASTENERS**, containing interesting and useful data on the application of bolted and threaded products.

FASTENERS

**AMERICAN INSTITUTE OF BOLT, NUT AND RIVET MANUFACTURERS**  
1550 Hanna Building • Cleveland 15, Ohio







## "These are a few we can talk about now"

Today, the eight Jack & Heintz plants are turning out 36 different war products—in ascending streams for the finest aircraft in the world. Our newest assignments are military secrets, but jobs we *can* talk about now are the instruments, auto pilots, generators, starters, motors and bearings that have gone to war by the tens of thousands.

This equipment is used in pursuit planes, bombers, transports, patrol boats, tractors, gliders . . . and even blimps. Its performance has been such that the Jack & Heintz nameplate is now a welcome sign of dependability to the men who gamble their lives on it day in every corner of the globe.

From the first, Jack & Heintz has led the

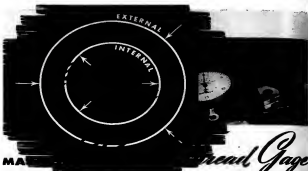


**JACK & HEINTZ**  
*Incorporated*

way in reducing weight, boosting output and increasing service life on every job undertaken. Engineering like this has helped keep America's air feet first in the war . . . it will be equally effective in holding that place in peace. Watch Jack & Heintz for new things in aircraft

*Jack & Heintz, Inc., Cleveland, Ohio, manufacturers of Aircraft Engines, Starters, Generators, Auto Pilots, Gyro Flight Instruments, Magneto's, Motors.*

*Buy More War Bonds and Stamps*



# MASTERS Thread Gage

## 4 TO 5 TIMES FASTER THAN PLUG OR RING GAGING

Bryant Thread Gages completely eliminate tedious, time-consuming threading of gages into or onto parts being inspected.

When inspecting internal parts, the segments are retracted by the control lever — the work is dropped over the segments — the control lever is released, and immediately engagement is made on all the threads. A partial turn of the work indicates overall accuracy within required tolerances, or accumulated inaccuracies of lead, taper, pitch diameter, thread form or the presence of burrs. External threads are inspected in the same manner, except that the segments are expanded to allow the part to be dropped inside.

The unique design of Bryant Thread Gages practically eliminates wear on the segments — it allows inexperienced help to inspect threaded parts four to five times faster than experienced inspectors using conventional gages — it eliminates the "feel" required in plug and ring gaging — it offers a method for complete, overall inspection of master plug and ring gages and a method of transferring their accuracy to production threaded parts.

Write today for illustrated folder No. G2 which gives complete details.



**Bryant CHUCKING GRINDER COMPANY**  
**SPRINGFIELD, VERMONT, U. S. A.**

AVIATION, February, 1940

# COUPLINGS

*are so widely used*

★

THEY'RE EASIER TO HANDLE,  
 FASTER, LONGER LIFE,  
 CUT DOWN COSTS

## SPEED UP PRODUCTION...

Harniss Couplings are first choice in all types and sizes of plants throughout the world because of their remarkable performance under every conceivable condition. • Simplicity in design means faster and easier assembly, greater production, less cost. • No trouble, longer life. • Harniss Couplings will take pressures from 2 inches to over 10,000 pounds without leaking. • They take rough treatment like a major business. • No parts are exposed, there's nothing to bend, jam or freeze. • Simplicity in operation is one reason. • Insure that every turn is full of time. For instance, with a Harniss Air Coupling you merely push plug into socket, it is connected, locked and air is automatically released on. To disconnect merely slide sleeve back, it is unlocked, disconnected and air is automatically released on. To disconnect merely slide sleeve back.

There's a Harniss Coupling made for air, oil, gases, gasoline, oxygen and acetylene. Send us for free industrial catalog.

AIR OIL  
GAS  
COUPLING

ACETYLENE  
COUPLING

GASOLINE  
COUPLING

SEND FOR Free CATALOG

then he said to himself

"Alas, poor world, I knew it well"



**EXPLAINING** how the old map is being rolled up and a new map is unrolling before us... Field Marshal Jan Christiaan Smuts, Prime Minister of South Africa, went on to say: "We are living in a world where we are FORCED to a fundamental revision of old concepts. The old world that we knew has GONE and it will NOT RETURN!"

Be thankful that to many factory men here in America that conviction has already been absorbed, because the urgency for production... the urgency for development... the urgency for redesign has made evident, throughout these critical early months, the need for better concepts.

By following old concepts in manufacture, the material proved too little and too late and too ineffectively.

Be thankful for the hundreds of new concepts that are now overcoming our peril. For example



"A New Map is Unrolling," he says

**LOOK, MARSHAL SMUTS,** how fundamental thinking is revising old concepts in the design and production of aircraft structures:

**NEW MAP** . . . the result of fundamental thinking with Arc Welding. Through the use of larger electrodes, simplification of design and fuller use of sub-assemblies, the manufacturer of this fuselage of a trainer plane cut its cost 60%. Formerly the bulk of the electrode was  $\frac{1}{8}$ " also. Now it is  $\frac{3}{16}$ " and  $\frac{1}{2}$ ", resulting in faster welding.



The Lincoln Engineer nearby will gladly help you revise old concepts with Arc Welding.

THE LINCOLN ELECTRIC COMPANY • CLEVELAND 1, OHIO

*America's greatest natural recourse*

**ARC WELDING**

# Phillips---

at your service

postwar flying fuels

Phillips  
**AVIATION GASOLINE**



## SPOTLESS *Charming Interiors*

Interior paneling, seat backs, kick plates in the airliner of the future will be decorative Formica.

The material has already served its apprenticeship in ships, trains, buses and in air, train and bus terminals.

It has proved that it has lasting beauty even in spots where wear is most severe. The hard non-absorbent surface does not stain. It resists mild acids, alkalis, solvents—so few ordinary

liquids can mess it up. It saves cleaning time because a swish of a damp cloth or a washing with soap and water is sufficient. On table tops it is cigarette-proof. It is lighter than glass.

Plane designers know it well as used for control panels, air frame and propeller parts.

The range of charming colors, patterns, "Reinwood" grains make it the leading modern decorative material where beauty must be preserved under severe conditions.



**THE FORMICA INSULATION COMPANY**

4628 SPRING GROVE AVENUE • CINCINNATI 32, OHIO



# 10,000 A.B.C.

*in less than a year*

Admitted to membership of Audit Bureau of Circulations June 30, 1944  
—30 months after its initial issue.



**A** RECORD without precedent in its field. Eloquent testimony from industry leaders of the urgent need for a publication devoted wholly and exclusively to the specialized needs of air transportation.

A RECORD of unusual significance because (1) circulation is carefully confined to airlines men, executives of aircraft and parts manufacturers and civilian, military and government authorities concerned with air transport; and because (2) AIR TRANSPORT's subscription price is \$5.00 a year in a field where \$3.00 is usually top.

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**AIR TRANSPORT • AVIATION • AVIATION NEWS**

McGraw-Hill Publishing Co., Inc., 330 W. 42nd St., New York 36, N. Y.

ALL THE FACTS IN THIS BOOKLET



Request your copy of "The Builders of Our Vertical Growth" — Transportation Industry" for the complete story of AIR TRANSPORT.

G. M. Meurer, Vice-President, American Airlines, Inc.: "I commend you for the brief, forceful and concise manner in which you have approached the future program of air transportation."

E. S. Garrett, President, Air Transport Association and Air Corps, Inc.: "Congratulations on AIR TRANSPORT. Have enjoyed reading it. You've done a great job!"

William R. Stout, Staff Editor, Division of Consolidated Aircraft Corp.: "The editorials and very relevant material throughout do us arise express the fundamental air policy which may well be of value to an ever-growing industry—aviation."

K. R. Ferguson, Vice-President, Northeast Airlines, Inc.: "Interesting, instructive and thoroughly worthwhile."



U. S. Navy's Grumman Hellcat Completes a Mission

# Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.



## COUNT ON Curtiss Commandos FOR TWIN-ENGINE ECONOMY

Lower the cost of air transportation and, at once, you raise the number of people and the kinds of cargo that will fly.

Coupled with such favorable features as its speed, capacity and dependability, the twin-engine economy of the Curtiss Commando will go a long way toward stimulating increased air commerce and consequent revenue for the airlines that operate it.

Ninety percent of domestic air travel is on flights of medium range. Over this range on a basis of block time, payload and direct flying cost, the Curtiss Commando is the most economical aircraft of its type. Curtiss-Wright Corporation, Airplane Division, Buffalo, New York.



# LOW TEMPERATURES

... and how their embrittling effect on metal parts can be avoided

Today, when choosing a metal for critical aircraft applications, a new factor must be considered...

The effects of intense cold on its properties.

The most common trouble comes, of course, from brittleness.

To avoid it, metals need high ductility and toughness, not only at ground-level temperatures but in the sub-zero cold of the sub-stratosphere.

As this ductility and toughness, in turn, must usually be coupled with other properties of strength, hardness, corrosion resistance, etc., the problem centers itself into finding a material that combines all the desired properties.

This is exactly the reason why the two Nickel Alloys are especially suited for parts to withstand sub-zero temperatures. In addition to their strength and resistance to corrosion, these metals exhibit a unique and valuable characteristic: Instead of becoming brittle they retain their high toughness values as their strength and hardness increase.

This is in marked contrast to the metals observed with many other engineering materials which, while retain-

ing reasonable tensile strength, grow increasingly brittle as the temperature drops.

### High Properties at Low Temperatures

The tensile strength of the high-nickel alloys at normal temperatures, for instance, is equal or superior to that of many steels. This strength and hardness actually increase as the temperature slides down into the sub-zero range. (See table below).

The important factor of freedom from brittleness is illustrated by the results of Charpy impact tests. Here, the normally high impact strength of nickel at ordinary temperatures actually increases an average of 10% at -110° F. Inconel loses slightly in ductility, but both Monel and "K" Monel

retain substantially the same high impact rating.

### Non-Magnetic Properties

Three of the high-nickel alloys are non-magnetic at sub-zero temperatures. (See Table).

Consideration of non-magnetic characteristics along with strength and ductility turns the spotlight immediately



on "K" Monel. This alloy can be age-hardened and will remain non-magnetic to as low as -120° F. Service cold work and age hardening do not change its non-magnetic characteristics.

A typical application is in the Sperry Horizon Instrument. Here the combined strength, ductility, corrosion resistance and non-magnetic properties of "K" Monel weigh it out as the ideal material for long, accurate service.

For further information regarding the properties and working of Inco Nickel Alloys, write for a copy of the booklet: "Inco Nickel Alloys for the Aircraft Industry." A copy is yours for the asking. Address:



PARTS FOR SPERRY HORIZON INSTRUMENT. Tough, strong, non-magnetic "K" Monel assures accuracy and longer life. These parts are machined soft, then heat treated for maximum strength and hardness.



THE INTERNATIONAL NICKEL COMPANY, INC.

AT WALK, NEW YORK, N. Y.



## PINPOINT REAMING

The patented Lemeco Dual-Spiral Hi-Speed Steel Expansion Reamer is fast, accurate, and economical. 500% greater expansion range, plus the fact that removable blades may be re-sharpened 8 to 10 times, enables one Lemeco Dual-Spiral to ream as many different size holes as 4 to 8 conventional expansion reamers. It eliminates boring, and the costly wear on plug gauges caused by abrasive left by boring. It runs smoothly over keyways and split bushings. Extension pilots are available for alignment jobs.

SPECIAL REAMERS DESIGNED  
TO MEET YOUR NEEDS  
SEND BLUEPRINTS

## 2-WAY FLUTES . . .

spiral in opposite directions simultaneously, effecting a clean, shearing action that flash-reams holes mirror-smooth. Equally efficient on any machineable metal or fibrous plastic. Blade segments are removable and economically resharpened. Good delivery.



## BOXED SETS

with dimensional range from .495" to 1.395". Given needs of most die, tool and maintenance shops. Set No. 28 pictured shipped complete with pilots in fitted hardwood chest. This set of 8 has an expansion range equal to 30 ordinary spiral reamers.

WRITE FOR CATALOG

# LEMPCO

5497 DUNHAM ROAD • RESPORD, OHIO



## AWAY AHEAD!

## Tobe Leads the Noise Elimination Field

WHAT are the real problems of radio noise interference? Can all man-made spark interference be eliminated? What is a sound source of information for the many problems concerning this entire subject?

The place to get these answers is at Tobe. For Tobe is the acknowledged leader in this field. For 17 years this organization has devoted its resources to the problems of noise elimination.

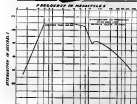
Tobe Filtering is a copyrighted term describing the Tobe system of blotting-out unwanted "man-made" noise. Why not make use of our valuable experience? Write us about your problems.

TUBE DEUTSCHMANN CORP., CANTON, MASS.



## CONTAINER DIMENSIONS

Length . . . 3 1/16"  
Width . . . 2 1/8"  
Height . . . 2 1/8"  
Overall length 6 7/8"





# LINDE'S METALWORKING METHODS

## Help to Speed Production . . . Lower Costs

Continuing savings of time, money, and materials result from the use of these Linde-developed methods in the production of steel. There are other Linde methods to help maintain steel-producing equipment and to form, treat, and fabricate steel.



**MECHANIZED HOT-SCARFING** — The removal of surface defects from semi-finished steel once contained recovering the hot steel from the production line . . . allowing it to cool . . . treating it to make defects visible . . . or chipping out these defects . . . and then reheating the steel for further processing. Today, through use of Linde equipment, mechanized batteries of oxy-acetylene blowpipes located on the roll tables literally "blast" faulty surfaces from the hot steel . . . and higher yields of quality steel are obtained without interruption of production.



**MECHANIZED FLAME-CUTTING** — For shaping steel in the fabrication of industrial machines and equipment oxy-acetylene cutting is offering important savings, both in time and in materials. The oxy-acetylene flame quickly and accurately shears through steel in straight lines, circles, or irregular shapes . . . work that otherwise would require massive machines. Linde engineering skill has helped adapt this "knife that never dulls" to high-speed work like the flame-planing of ship steel shown here. In one operation plane edges are trimmed to exact size and beveled like this — for welding.



**FLAME-GOUGING** — Oxy-acetylene flame-gouging is a rapid and economical method of forming U-shaped grooves by removing surface or edge metal from rolled, drawn, forged, or cast steel. Gouging nozzles can be fitted to ordinary blowpipes to quickly remove rust puffs from castings, to rough-shape steel and thereby reduce machining time and costs, to prepare plane edges for welding, to remove roots of manual welds in preparation for backgouging welds, to prepare cracked or broken steel parts and castings for welded repairs, to remove temporary welds, and to fabricate parts requiring a groove.



**FURNACE TAPPING**

Use of the oxygen lance to tap the top hole, the opening quickly made for molten steel to pour from the furnace.



**DESEAMING**

Where mechanized conditioning of steel is not feasible, or for secondary conditioning, manually operated flame-scarring equipment is used.



**COLD-SCARFING**

Some special steels, such as slabs of armor plate, are allowed to cool before scarfing by Linde machines that move along the slab.



**BULLET-CUTTING**

Flame cutting machines developed by Linde are used in the production line to cut billets and bars to length quickly, several pieces at a time.

## Apparatus and Supplies for Every Application of the Oxy-Acetylene Process



like cut-off machines; automatic welding equipment; and tools for plane-edge preparation.

### MACHINE APPARATUS

Included in the Oxtwin line of apparatus are portable and stationary oxy-acetylene machines for cutting shapes or straight lines, flame hand-sawing apparatus; bar and

### HAND APPARATUS

Oxy-acetylene apparatus which may be ordered from Linde includes oxy-acetylene blowpipes for all welding and heating work, oxy-acetylene cutting blowpipes, cutting attachments, and nozzles; oxy-acetylene descaling and flame-planing equipment. Oxtwin apparatus is supplied from Linde offices and warehouses. The Finner and Finner-O-Weld line, and Finner-O-Lite oxy-acetylene appliances for soldering and brazing, are distributed by industrial and automotive jobbers.

### WELDING RODS AND SUPPLIES

The many kinds and sizes of Oxtwin high quality welding rods make it possible to select the one that will give best results on each job. The Oxtwin line also includes fluxes, gloves, goggles, lighters, hose, and lubricant paper. Rods and supplies may be ordered from Linde or from automotive and industrial jobbers.

### GENERATORS AND MANIFOLDS

Oxtwin acetylene generators have maximum generating capacities of from 50 to 5,000 cu. ft. per hour. Oxtwin manifolds centralize oxygen and acetylene supply from cylinders.



### OXYGEN, ACETYLENE, CARBIDE

A booklet describing use of Linde oxygen, Finner-O-Lite acetylene, Oxtwin carbide, and Oxtwin apparatus in these and other processes will be sent without charge on request. Ask for Form 1258A.



BUY UNITED STATES WAR BONDS AND STAMPS

## THE LINDE AIR PRODUCTS COMPANY

One of the world's largest air and gas companies  
100 EAST 42ND STREET, NEW YORK 17, N. Y.  BRANCHES THROUGHOUT THE WORLD  
BOSTON, CHICAGO, CINCINNATI, CLEVELAND, DETROIT, PITTSBURGH, PHILADELPHIA, RICHMOND, ST. LOUIS, ST. PAUL, WASHINGTON, WILMINGTON

The words "Linde," "Finner-O-Lite," "Oxtwin," "Oxtwin-O-Lite," "Finner-O-Weld," "Finner-O-Weld," "Warrior Solder," and "Luncheon" are trade-marks of Union Carbide and Carbon Corporation or its units.

## Now ask HIM if the 2700 Lycoming Inspections pay! . . .

There are 358 parts in the  
Lycoming 68.

And approximately 2700  
inspections! . . . All known

laboratory inspections—including

X Ray and Magnafix:

Every practical inspection,  
including test runs and teardowns  
for each individual engine.

Altogether—an average of 5  
inspections per part.



LYCOMING MODEL G-68, developing 65  
h.p. at 2500 rpm.

Weight—only 165 lbs., 7-10% less than  
competitive engines.

See consumption at 21-23 gals. per hour,  
50-55% below our competitive engines.

Adding aircraft "Powered by Lycoming"  
are: Aerocraft, Beechcraft, Bellanca, Dornier,  
Cessna, Cessna, Cessna, Cessna, Cessna,  
Spartan, Stinson, Taylorcraft, Volcan,  
and Lycoming power your aircraft.



Too much care, you say? We think not. Because a life can depend  
as much on a 65 h.p. Lycoming as on a giant 2,000 h.p. diesel engine.  
They are built with just as much care and accuracy.

And that meticulous production-care shows up in operation. Mr.  
John A. Clinch, owner of the Clinch Flying Service, Municipal Airport,  
North Platte, Nebraska, who has a fleet of 15 planes powered by 65  
h.p. Lycoming, says . . .

“Our records prove the Lycoming 65 can stay at the job long  
and deliver a more economical operation record than any other make  
of engine.”

### LYCOMING

AIRCRAFT ENGINES . . . 55-300 H. P.



Licensing Division  
The Avco Corporation  
Dept. G-5, Willowport, Pa.

POWERED BY LYCOMING—THE ENGINE WITH A PROVEN PAST AND A BRIGHT FUTURE

AVIATION, February, 1946



## It's Easy to See Why They're Better...

It's a funny thing about wrenches. You use them all  
the time. They're the most important tools in your  
kit. You know which ones do the job best—which  
are the longest. But chances are you never  
stop to think why.

Now you take a good look at a Bonney Wrench,  
and you'll see why it's better.

Openings in a Bonney Engineers' Wrench, for  
example, aren't just milled—they're precision-  
ground. They fit the nut exactly—no slipping, no  
striking. The jaws are tapered to give you more turn-  
ing force. They're reinforced with extra metal at the

points of strain. The handles are rounded for an easy,  
comfortable grip. And something you can't see—to  
make Bonney Wrenches the strongest and toughest  
on the market, each one is given our special pyromet-  
er-controlled heat treatment.

We put a lot into Bonney Wrenches because we want  
you to get a lot out of them.

If you do not already have a Bonney Engineers'  
Wrench Set, ask your nearby Bonney distributor or  
jobber to order one for you now. All Bonney Tools  
are sold exclusively through distributors and jobbers  
from coast to coast.



ONLY FORCE & TOOL WORKS • 711 N. MEADOW ST. • ALLENTOWN, PA.

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**BONNEY**  
TOOL



AVIATION, February, 1946



## BETTER PERFORMANCE AND DEPENDABILITY FOR EVERY AIRCRAFT ENGINE

The ultimate criterion in aircraft spark plugs is their ability to yield better performance and dependability regardless of operating conditions.

Champion Ceramic Aircraft Spark Plugs have established new high standards of performance and dependability, long life and minimum service problems in engines of every size and type on active duty with our Air Forces. This is the fruit of over 35 years devoted exclusively to the

production of better, more dependable spark plugs.

This outstanding success is not only aircraft proves that Champion design specialization provides a perfect solution for those who seek the utmost in spark plug performance. Use Champion with confidence. Champion Spark Plug Company, Toledo 1, Ohio.



C28—Unshrouded



DEPENDABLE  
**CHAMPION**  
**SPARK PLUGS**  
FOR EVERY AIRCRAFT ENGINE



C28—Shrouded

# SCHATZ BALL BEARINGS

## FOR EVERY TYPE OF INSTALLATION

**SCHATZ MANUFACTURES BALL BEARINGS FOR EVERY PURPOSE AND ANY PRODUCT**

**STANDARD TYPE OR MADE TO YOUR SPECIFICATIONS**







## Seamless Steel Tubing . . .



### PUTS STRUCTURAL STRENGTH INTO MOVABLE EQUIPMENT

Strength and light weight make seamless steel tubing a preferred material for numerous pieces of movable equipment used in factories, service stations, and overhaul shops. The same qualities are of primary impor-

tance in many other structures. Tubing supplies demand and offers a wide range of diameters, wall thicknesses and mechanical properties. Also, tubular structures are easy to fabricate and simple to service or repair.

Michigan welcomes inquiries about the availability of seamless steel tubing for all proposed structural uses.



**MICHIGAN SEAMLESS TUBE COMPANY**  
SOUTH LYON • MICHIGAN



# SCHRILLO CRAFTSMANSHIP

... at no added cost!



- ① Simple tool holding shafts without flange
- ② Allow steel generated gears to remove the required angle quickly, efficiently
- ③ Allow steel shafts bent and ground to exact 90° fits on the compound set and shape
- ④ Shaft bearings are self lubricated

The Schrillo Angle Drive has been developed and improved for efficient and dependable service in relatively inaccessible "hot" or "gray" places common to aircraft manufacturing and maintenance. The assembly and all of its component parts are typical examples of Schrillo's craftsmanship featuring the finest of materials, coupled with superior design and workmanship. This new device is the Schrillo line of precision tools is introduced with the character and quality of its previous introductions. Priced at only \$14.00, without doubt, it will be maintained by the factory in first class working condition at a nominal charge. Immediate delivery out of stock. A complete stock of material is also available. Order by the Tool Number 1190.

Make a Schrillo Angle Drive your own tool.

Overall length, 7 1/2 inches.  
Height, 5 1/2 inches.  
4-28 or 10-32 threaded drive. (Squid)

## SCHRILLO

LOS ANGELES, CALIFORNIA



# FINE STRIP STEELS

Hot and Cold Rolled  
Carbon and Alloy  
Grades

## Stainless Grades:

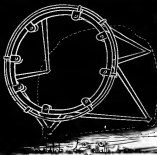
High Tensile,  
Heat Resisting, or  
Drawing Quality  
as required

The Name and the Products are

# Superior

Superior Steel

## Answers... with quality steel tubing



If you could check at a glance all of the wartime production and structural problems on, say, aircraft engine accessories—in finding general production short runs—or in adding capacity to fighting "front" equipment—you'd likely be impressed at the number of "answers" which have been found in steel tubing. Steel tubing offers "strength-weight" advantages in more ways than ever before—a fact revealed in the overwhelming variety of demands on OSTEKO's production.



The "Strength Answer"—typical of the many war-time and wartime steel answers "kitty on tap" in quality at OSTEKO.

OSTEKO recognizes the tremendous benefits quality steel tubing can offer its customers both structurally—and production-wise. That's why OSTEKO checks quality in every operation. For example, on this page is shown the magnetic inspection which separates anomalies and shows up cracks, laps, small runs and other defects. Dependable delivery of quality through the years has earned for OSTEKO an enviable record of low rejects—an enviable reputation for workability and adaptability on the production line.

Are you planning postwar superiority in your field? Why not check with the OSTEKO engineers to see how OSTEKO steel tubing can contribute to that superiority. Simply contact the sales office nearest you:

CHICAGO & ILLINOIS: OSTEKO Sales Bldg., 26 N. Wacker Drive  
CLEVELAND 14, OHIO: OSTEKO Sales Bldg., 1238 Cleve Ave.  
DETROIT 5, MICHIGAN: OSTEKO Sales Bldg., 5417 E. Grand Blvd.  
HOUSTON, TEXAS: OSTEKO Sales Bldg., 9000 Westchase  
LOS ANGELES, CALIF.: OSTEKO Sales Bldg., 9000 Wilshire  
MINNEAPOLIS 5, MINN.: OSTEKO Sales Bldg., 400 Hennepin Ave.  
MOBILE, ALABAMA: OSTEKO Sales Bldg., 500 1st Ave. S.E.  
MONTREAL, QUEBEC, CANADA: OSTEKO Sales Bldg., 500 1st Ave. S.E.  
NEW YORK CITY 17, N.Y.: OSTEKO Sales Bldg., 70 West 45th St.  
PHILADELPHIA 5, PA.: OSTEKO Sales Bldg., 150 N. Wood St.  
ST. LOUIS 8, MO.: OSTEKO Sales Bldg., 301 Roberts Ave.  
TOLSON, N.C.: OSTEKO Sales Bldg., 400 N. Main St.  
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THE OHIO SEAMLESS TUBE COMPANY

PLANT AND MAIN OFFICE - SHELBY, OHIO

MANUFACTURERS OF SEAMLESS AND ELECTRIC-WELD STEEL TUBING





**"I TOLD You!**  
**-it's a Job for**  
**Aeronautical Products, Inc."**

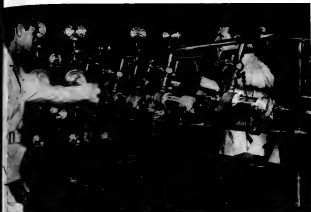


When your machining specifications say "Tolerance .0005," to us it means five ten-thousandths of an inch, and not a whisper more, or less. Tolerances like these, and much finer, call for experience, skill and machinery of vast precision. So, if YOUR post-war assemblies require precision machining in volume, right from engineering through to the final inspection, it's a job for Aeronautical Products, Inc. Here in one complete organization is everything your job needs. Controlled responsibility . . . no back-passing. You get your answers straight from the shoulder and backed with performance. If our set-up sounds good to YOU, ask your secretary to write our Executive Sales Office, Detroit, for an impressive list of plant equipment and complete facilities.

\*  
 BUY  
 MORE  
 BONES \*



• THE SUCCESS of The Aeronautical Products, Inc. Helicopter, designed and built by our own craftsmen, promises new accomplishments in the post-war age of flight



**A.P.I.** — says this

## HYDRAULIC TEST LABORATORY

Interstate designed it for Interstate: to make scientifically certain that every hydraulic unit produced in this plant is 100% O.K. The Hydraulic Test Bench pictured above has many unique features. For instance:

It can test many units simultaneously. It can test them under a great variety of conditions. It has a testing capacity up to 3,000 lbs.

In addition, it completely filters hydraulic fluid — through a two-way filter mechanism. The first filter reduces all foreign particles down to 10 microns; the second filter reduces them down to 2½ microns.

This Hydraulic Test Bench is another proof of the engineering skill and production accuracy that go into every Interstate precision unit.

**Interstate**

AIRCRAFT AND ENGINEERING CORPORATION • EL SEGUNDO, CALIFORNIA

AVIATION, February 1945

ANOTHER EXAMPLE OF  
**CREATIVE  
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# REDEDICATION

## An Obligation to Our Fighting Men

**D**uring the last few weeks we have been forcibly reminded that so long as we still are fighting either of our major foes, first claim upon the productive resources of the United States—its manpower, materials, facilities, and industrial facilities—must be the production and delivery of munitions and war supplies. All other claims are secondary. No responsible citizen could have it otherwise. For in this war even more is at stake than our existence as a Nation. We dare not forget that we are engaged in a struggle that challenges the fundamental values upon which our civilization has been built.

It is not easy to list the values that we are fighting to uphold. They have been clothed in a variety of shapes for the centuries. They will assume new forms in the years ahead. But they have an inner consistency that no man the world over can feel and recognize; the right of the commoner against the noble, the right of the individual against the state, the right of trial by jury, the right to vote, the right to an education, the right to freedom of speech and worship, the right to work in a sphere of one's own choosing, the dignity and the equality of the individual under the law—these are our cultural heritage, painfully won and often precariously held over the ages, always to be won, redefined and buttressed by each succeeding generation of men.

The preservation of this vital core of values, and its transmission to our sons and daughters depends upon our victory in this struggle. So these things which are essential to victory must come first. And since the production of war munitions is overwhelming volume and early can hasten that victory and save countless lives of our fighting men, no effort that will contribute to its end should be regarded by us as a sacrifice.

• • •

The present is no time for self-congratulation upon our achievements either in the theaters of battle or of production. The mounting casualty lists should suffice to refute the error of any such indulgence. The most that we be in reasonable taste and good conscience is that performance in both fields is such as to warrant our full confidence that we can carry to successful conclusion the tasks that remain to be done.

For is there profit in even observing, much less doing, that the tasks ahead are more formidable than those which were defined for us a few short months ago.

Then, all of us—military leaders, government officials, workers, and business men—were riding a crest of optimism as to an early end of the war in Europe and as to the character and development of the war against Japan. Already we had begun to turn anxiously toward the problems of reconversion which then seemed as near at hand. Reckonings for war production, based upon the best available estimates of need, called for a 5 billion dollar reduction from 1944 performance, even though we might have to maintain a two-theatre war, and for a 40 percent reduction in the event of an early victory in Europe.

Today, these foreward estimates have been revised sharply upward. That is true both of the 1945 requirements to meet the needs of a two-theatre war, and of requirements for the Pacific war once the European phase is ended. For this upward revision four chief reasons are responsible:

1. European battle experience has shown markedly greater use of expendable munitions than was provided in the forecasts upon which our original production schedules were calculated; the result has been a depletion of munitions on a scale that would become dangerous if allowed to continue.
2. Experience has also demonstrated the need for new types of weapons or increased complements of some existing types to match new enemy equipment or tactics.
3. A less easy optimism as to the early ending of the European war has given rise to a growing disinclination to gamble on the approximate date.
4. An increasing conviction prevails that the war against Japan may require ground-army operations on the Asiatic mainland on a scale greater than originally predicted.

But if these changes in the fortunes and outlook of war have raised our estimates of military requirements, may not subsequent favorable changes in the military situation cause them again to be revised downward? It is entirely possible. But our military men have learned that they cannot safely discount what might *possibly* happen as something that will happen. Their working on the production front also must learn that lesson. Fortunately, the record shows that we have been able to maintain a war production almost equal to that of the rest of the world combined, even while we produced for civilian use on a scale that has been large even by our

even pre-war standards. So we have ample margin to whip whatever war job may be required of us. As now defined, the task will not be easy. But it can and will be done.

\* \* \*

What, then, is the production task with which we are charged? Our 1945 production for the two-theatre war now calls for the substantial maintenance of the overall levels reached in the latter months of 1944. But there is a shift of emphasis. Almost half of the programs for specific equipment items are declining. A few are scheduled to hold level. About 42 percent are scheduled to rise sharply. That means that workers and facilities must be shifted to meet the expanding programs. At the same time the armed services are calling for many more men than can be supplied from those who become newly eligible to the 18 year old age group. That means further drafts upon war workers. It means also replacements for them when they are taken from the expanding programs. Finally, events demand that we produce as much as possible of many items during the first half of 1945.

Our task, then, is one of intensified effort for the immediate future, with multiple readjustments at a stage when adjustments are hard to make. Materials for which demand was easing as pipe-lines were being driven in anticipation of falling schedules again are tight as the pipe-lines are being refilled to meet augmented requirements. Men, women, and facilities must be shifted from less essential to more essential tasks. What must be done will be done. But unless there is much voluntary accommodation, it will be necessary for us to suffer a formidable amount of governmental direction which none of us likes, many of us deeply resent, and all of us, when personally affected, vociferously protest. The more we police ourselves, the less we shall be policed.

\* \* \*

Even after Germany has been defeated, we shall still face a far from light production requirement to continue the war against Japan. As currently defined this phase might require war expenditures at something like \$70 billions a year, an ever-all reduction of approximately 20 percent from the \$90 billions spent in 1944. Reduction in materials output would be somewhat greater, probably from 25 percent to 30 percent below 1944 levels. But it is important for us to acknowledge that the reduction is going to be substantially less than the 40 percent previously estimated.

Only a few months ago there were those who questioned sharply the possibility that we might need 40 percent of current munitions output to win the Japanese war. Now the judgment of the military is that 70 percent will be none too high.

Actually the latter level would represent an increase of little more than 50 percent above what now is being produced for the Pacific area. That, certainly, is a modest estimate when we reflect that we shall inevitably more than triple the Army forces assigned to that theatre.

Such a program probably would give us a munitions supply from three to four times that produced by Japan, but it is believed that we shall need that much to compensate for the advantages derived by Japan from the fact that she will be fighting a defensive war, from the volume of her accumulated stores, from her prepared positions, her shorter lines of supply and transport, and from her large troop reserves, the bulk of which we have yet to meet in battle. Certainly our present 3 to 1 production edge over Germany does not appear to be excessive.

The more modest V-E Day cuts contemplated by the present plan will mean a less acute reconversion problem when they are made, but will leave a greater one to be met at the end of the war. They will even probably a net increase of not more than 4 million workers available for civilian work during the transition period. Their orderly absorption should present no overwhelming problem. Indeed, we now are warned by Washington that war production following V-E Day may require the protection of considerably closer control than was contemplated under the 40 percent cuts previously expected.

\* \* \*

In short, we face for the immediate future a very difficult production job. It is made the more formidable by the fact that we have dulled the home edge of our will to produce by our premature expectation of a reduction in requirements. Now we are told that the level of war production for the immediate future is up, and it is unsafe to discount the date of victory in Europe and that the amount of leeway for reconversion after the defeat of Germany is less than had been anticipated.

Accordingly, we must rededicate ourselves to the task of driving war production up. We must do without some of the things that we have enjoyed on the civilian front rather than demand more of these things; we have still to devote our abilities and energies first and foremost to the demands of war.

Whatever will assure and hasten victory must have first place in any statement of American policy.

Without victory, our sons, and the underlying values upon which they are based, will be extinguished. Blasted out by the opposing aims and values proclaimed by our enemies.

The needs of our fighting men must be put first. For, unless we win the war, the National aims and policies of the United States will cease to have meaning in the world.

*James H. McGraw, Jr.*

President, McGraw-Hill Publishing Co., Inc.

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**\* SUGGESTED USE of Flexlock in fuel system to show how it might be applied.** Company picture shows how the grip both pipes securely. Other possible applications—high pressure gasometer seals for gaging conditions through pressure chamber bellhousings, etc.; flexible joints in ball and splined tubing carrying gases and liquids.



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## America's Policy Makers Need Our Industry's Help

IT IS EVIDENT that the immediately ahead the basic pattern for the postwar aviation industry will be wrought. The whole future of aeronautics in this country depends upon the imminent decisions of the present Congress and of the several government agencies concerned with problems bearing directly on our national air power policies. Is a larger sense even to better security of the nation depends upon these developments because the war has shown with great clarity how closely the future of aviation and the future of the nation are intertwined.

Important decisions will be made to determine the program governing the disposal of war-surplus aircraft and aviation equipment. This is one of the knottiest problems before us. The effectiveness of its solution will affect the future of every branch of the aviation business. Unless the market is relieved of the huge surplus which is bound to accumulate before the war ends, there is grave danger that the manufacturing spirit of the industry will be scattered to other fields and perhaps never re-assembled.

The disposition of government-owned manufacturing facilities will come in for further examination and its proponents of aeronautical industry will be heard advocating that the industry be placed in the position of competing with its largest customer. One of the most eloquent answers to this fallacious thinking is the present French experience in which government ownership of a demoralized industry that even the hope of adequate war production faded before France fell.

THE DELICATE DEMARCATION between the functions of government and industry in research and development is scheduled to be worked out by this Congress and a projection of past practice will furnish a sound formula for the future. The public interest demands a continuous and highly accelerated program of technological development which is the very lifeblood of aviation. The government laboratories must not shirk their vital responsibility of providing basic research (they have effectively refrained in the past). The armed services must continue their catalytic action in evaluating progress and encouraging the industry to develop new and better designs in an unending process. Peace-time procurement policies must be devised to eliminate enough of the gambling element in experimental contracts to enable manufacturers to justify them before their stockholders. And the industry must not shirk its responsibility to utilize basic research to create the finest aircraft and equipment in the world.

Our national policy with respect to airport develop-

ment will probably be formulated this year. The division of financial responsibility between the federal, state, and community governments should be determined, and a long-term plan to build airports as we have built highways should be set up as quickly as possible. Much of the future growth of personal flying depends upon government and community activity in this field.

Many other problems vital to aviation's future will be ironed out this year. The move to relax regulations governing general plane operation and the development of a postwar network of feeder airlines are prominent among them. The center of much of this policy formation will be the nation's capital, but other matters vital to aviation will be considered by various state legislatures.

THE MEN who are charged with the grave responsibilities of policy-making in government are not supermen. They are normal human beings, even as you and I. And they are thirsty for competent information to help them do their difficult jobs more effectively. In the past they have often been misled by crackpots and publicity seekers whose testimony was based more on self interest than on the truth. And the public servants were forced to depend upon instinct to distinguish between the unusual and the sound. It was and is, and recently that the industry leaders who really know the score took time out to go to Washington to present the facts.

The handful of aviation manufacturers who have taken valuable time out to present the truth about the industry to the various agencies of government deserves high commendation for their foresight and their contribution to the future of the industry and the nation. They have been welcomed by members of both political parties. Their strength and their effectiveness have been born of their willingness to present facts impartially without trying to hide any part of the truth.

This work must go forward in the critical months ahead because there will always be new problems in an industry whose very basis is rapid change. It is the responsibility of every member of the industry to support this activity and to contribute to it when called upon. By so doing it will be possible for aviation to establish an example of industry-government relationship which it will behave other industries to follow.

*Leslie E. Zwick*  
EDITOR

# AIR POWER—THE KEY TO PEACE AND PROSPERITY\*

By EUGENE E. WILSON,

Vice Chairman, United Aircraft Corp.,  
and President, Aeronautical Chamber of  
Commerce

One of aviation's foremost spokesmen here gives the ingredients for a national air policy which might well foster the world's fourth great—and possibly permanent—era of peace, the Pax Aeronautica.

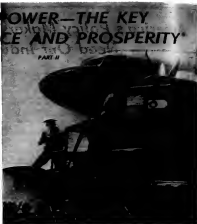
As events have been developed in this world of ours only on the basis of national policy; peace-making nations like the United States developed their aviation industries along the lines of commerce—Germany and Japan developed theirs for aggression.

It was only because the United States had strong Air Commerce—that we commonly call our transportation—and an unqualified Aircraft Production Act—that it was able to build up an Air Force equal to those of the aggressive nations.

While World War I influenced the development of the airplane more than the airplane influenced World War I, the latter influence has been true in the current conflict. Thus it will be well to appraise the coming peace as it is likely to be affected by Air Power; that is, the sum total of Air Force, Air Commerce, and Aircraft Production.

All will be greatly affected by national policies—foreign and domestic—and such policies must have regard for the truly fundamental character of Air Power. For here is a new medium of communication and commerce, a new share of unique character and far-reaching influence.

We have seen the French Air Force demonstrate under a lack of progressive policy; we have seen the British, whose maritime policy had helped make the rebirth of a small group of islands the founders of a world empire, function less surely in the air. We have seen the Germans, disarmed by Treaty, re-arm and combine Air and Ground



"One of the great forces for peace is freedom of access to the goods of the world . . . Air Transport can become the catalyst of a new dynamic era of expanding commerce." (United Aircraft photo)

Force in a bold bid for world power that came too close to success. We have seen Italy and Russia and Japan make their bids for Air Power. Of the three, it is possible Japan had the broadest concept.

It should be recalled that during the Washington Extension of Armaments Conference and the London Conference, when Japan was apparently accepting the 5-5-3 ratio of surface ships, Rear Adm. William Mitchell was forecasting the coming of the battleship—and Adm. William E. Sigsbee agreed with him. The Japanese statement must have been impressed with this, and when the U. S. carrier force manifested in the Pacific, must have understood the significance of Air Force that we in the United States hardly appreciated.

In any event, Japan not only expanded its naval air force, but apparently assigned to submarine aircraft a vital role. History may record that

the navy was actually relegated to first place in their thinking, and the air force, however subordinated, shared with responsibility for controlling its sea lanes.

However this may be, we find the German and Japanese aviation men firmly thwarted only with the aid of help of American Air Force. Behind the fighting forces of the United Nations was the overwhelming aid of superior aircraft designed and produced by the American aircraft industry in world history.

America's air policy, as outlined by Dwight D. Morrow, was quite simple. It recognized a strong Air Force as a vital necessity to our national security at new the backbone of the Air Force as a strong, competitive, private industry, able to maintain technical leadership

\*From the message of the author's book, *Air Power and Peace*, published by McGraw-Hill, Inc., 1937.

and in expanded in an emergency to carry the full brunt of war while the backbone of industry was being conserved. It recognized the place of Air Commerce in peace and war, and of national defense and the training of such a profession. It indicated the necessity for planned programs designed to give continuity to development and education, and the healthy financial culture is essential to progress. And, as it came a fundamental concept of the mutual interdependence of the land forces and Aircraft Production. The Army and Navy had to direct a program that would bring to bear the full creative forces of performance, education, and still avoid destructive internal competition. This same principle controlled the orderly economic development of Air Transport, domestic or foreign. Reasonable regulation avoided the incentive of free competition without the destructive disadvantages of unlimited competition.

The line of demarcation between government and private industry was strictly drawn, yet both were well improved. Business relationships between the commercial airlines, personal ties, and personal plane manufacturers were the normal relationships of urban individuals. The government avoided loose competition with private industry, both in design and production. The armed forces evaluated the results of competition in the laboratory and in the field. They laid down their own requirements and exactly required the "impossible." But invariably it was forthcoming.

Here is a pattern for relationship of government to the individual or organization that is wholly within the spirit of the American concept of individual freedom under law. It is a pattern that could well be followed in other instances.

country-government relations in the future. Freedom is not alone a pleasant material condition but a vital, dynamic, constructive spiritual force that has produced the greatest power in world history.

The pattern of domestic air policy is well established. That for the foreign field remains to be delineated as the world works over the foundation established by the International Civil Aviation Conference held last year in Chicago. Here we move out of the realm of Air Force for war, and into that of Air Power for peace.

The function of the Air Force in peace has already been outlined by the Des Moines Oakes Conference. An Air Force to comprise contingents from the Powers will be the instrument of security—a Security Air Force. And Air Force is suited to this purpose to a degree not approached by Ground or Seaborne Forces. Its capacity for action directly against a people, rather than against their armed forces, is a decisive quality.

If an agreement can be had as to collective action, then the responsibility will rest on the individual country. The United States has two instruments available for this purpose, and can use one or both as circumstances dictate. The Army's long-term striking force, using self-sufficient Boeing Superfortresses and Convair Bombers is one; the Navy's Seaborne Air Force is another.

But we must not lose sight of the fact that these forces must be kept at a high state of readiness and advanced technical development. The background and rocket berth forecast rapid changes; still other developments are indicated. These highlight the place of strength design and production in the Security Air Force.

U.S. "The outstanding lesson of this war is the abundant power of individual initiative and enterprise under freedom," which was behind the fighting force of the United Nations. The American aircraft industry, which designed and produced by the American aircraft industry, has been the backbone of the United Nations' fighting force. Here are the United States and the United States' Air Force. (United Aircraft photo)



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The future of this country in peace and in war is to a great extent in the hands of American scientists in industry, in universities, in schools, and in government. The leadership, in connection with the development of new weapons, must rest in the armed services, but the actual research, engineering, and development must rest in private hands and be stimulated by the national forces best calculated to accelerate it.

The outstanding lesson of this war is the miraculous power of individual initiative and enterprise under freedom. This has shown itself not only in industry and in the armed services as well. Both Aircraft Production and Air Transport flourished in the United States under the stimulus of private competition, reasonably regulated in the broad public interest. Under this policy, skilled designers and creative engineers conceived new technologies to obsolete the old and provide new employment and wealth for the many.

Meanwhile, the need for an Air Force is increasingly sharpened by other things. Among the causes of war is disruption of commerce and trade. One of the great forces for peace is freedom of access to the goods of the world. Another is domestic prosperity, and the two go hand in hand. The earlier commerce is restored, the less the need of an overwhelming Security Air Force. Here is the opportunity for Air Transport.

Air Transport, under the American system, has proved self-sustaining even in direct competition with highly developed surface transport. In the reconstruction period following our Civil War, the railways furnished the mechanism for expanded trade and industry. Similarly, following World War I, the automobile was the new vehicle

about which reconstruction focused. The progress of mankind has paralleled the progress of transport. Now, the airplane, forged in the crucible of war, may become the instrument for forging a durable peace.

If Air Transport served only as a means of bringing leaders of government and industry into quick access to the amenities essential to the restoration of trade, it would justify itself. But, of course, it has a far greater role than that. Coordinated with other forms of transport, it can become the catalyst of a new dynamic era of expanding commerce. And the economics of Air Power are such that this requires no subsidy under reasonable conditions.

For instance, as the world progresses, new sources of oil will have to be developed. Much of the world outside the United States has been only lightly prospected. If Americans continue to participate in the work of finding oil, they will need international air transport to every corner of the earth—air transport which transcends the great distances of the globe into hours instead of weeks and months.

This is but one of many examples, for nations are distributed materials and peoples all over the globe. No nation or people is self-sufficient. Each needs to trade with others on terms advantageous to all. Tourist travel is one form of trade. The wide variations in living standards among peoples is a challenge to statesmanship. Unless it is met, frequent wars seem inevitable. Enterprising traders of the past found ways to trade under even greater difficulties than these now encountered. They are likely to re-emerge.

A great new force has been released upon the world. Thousands of young men in their early twenties have learned to fly and to command large and complicated aircraft. They and their crewmen have had a taste of individual initiative, of leadership, and of teamwork they might never have experienced in peace. Some of them will

want to range far afield in pioneering new countries, new air routes, new enterprises. Some will not be content with the old routine. They form a new force for international expansion, and Air Commerce should provide new opportunity for them.

From the viewpoint of Aircraft Production we see that if, as the demands of the Air Force diminish, the requirements of Air Transport increase, the reconstruction of the manufacturing establishment is facilitated. A growing demand for new and improved transport becomes the basis of transition from war to peace.

Disposal of war surplus transport planes may well create a demand for newer types if it is handled on a sound economic basis designed to expand domestic and international transport. On the other hand, dumping of war surpluses, or permitting them to overwhelm the market, could smother the work of recovery.

In fact, in order that the aircraft manufacturing establishment may even survive the drastic cutback from war to peace, several steps are necessary. First, contracts must be terminated in the mass spirit in which they were negotiated; second, production must be reduced to a minimum; third, an all-long-term continuing program of development of advanced transports and new military models; and third, war emphases must be administered courageously in the public interest so as to insure the expansion of technological progress and not stagnation. If Aircraft's present position is the backbone of Air Force, it is a public asset to be cherished and commended.

This brings up a whole new relationship between the requirements of national defense and their impact upon the economy. It is commonly accepted as a fact that expenditures for national defense are a burden tending to depress living standards. However, under the processes by which U. S. aviation has developed, there were compensating factors. The armed forces, seeking

technical progress, fostered technical development through private industry. Those improvements susceptible of employment in Air Transport paid a return and tended to reduce costs.

The expansion of economic Air Transport on a profitable basis contributed to lowered travel costs and reduced expense rates, thus promoting domestic and foreign commerce. The supporting manufacturing and other industries have benefited the enterprise from employment and new markets. Opportunities sprang out of the adoption of new technology to trade in commerce. Air Power, acting through Air Force to keep the peace, has function through Air Transport and Aircraft Production in the same service. And while it may prove unexpected to balance the wealth created by this new industry against the costs of new and better weapons systems for the Air Force, it is obvious that substantial gains will be secured.

In fact the recovery could, in time, exceed the original cost just as it did in the Western railroad construction. Beyond that the savings resulting from maintaining an adequate air force as insurance against war are incalculable.

Here indeed is a revolutionary development. Air Power, as we have seen it function in war, has been devastating. Air Power dedicated to peace can be correspondingly beneficial.

There have been three great sea wars in modern history. The Great War was the Russian, the Victorian, and the present-day. The Russian was the dominant Sea or Land Power at the hands of five people drove them from the high seas and provided the peace conducive to overseas trade. All the other requirements having been met, necessarily, remembered.

Now, we find in our hands a new and even more effective Power, that of the Air. The United States has the dominant Air Power, an unexcelled Air Force, the largest productive capacity in the history of the world, and the most extensive domestic and foreign Air Commerce.

United States air policy is important to the security of her people—it is vital to the peace of the world. Most of the world has agreed with our policy as was shown by the Chicago conference. Out of it may easily come fourth and possibly permanent air control—the Pan American.

Such a peace requires no new theory but derives from our experience in the World Wars in a single generation. It has as its basis for maintaining that Act Policy—and with it the peace—can be found in the five major points which I presented in the accompanying letter.

hard-earned experience has now taught us that nothing is so vital to American might and security as our air power. But this formidable task couldn't have been attained or maintained had it not been for the unfettered functions of research and development. Hence —

## WE MUST RETAIN TECHNOLOGICAL SUPREMACY

BY MAJ. GEN. KENNETH B. WOLFE

Chief, Engineering and Procurement, ATSC

**A**T THE OUTBREAK of war—Dec. 7, 1941—this great industrial nation had an air force which was pitifully inadequate, numerically, to cope with enemies in the West and East who had built up the greatest fleets of combat aircraft the world had known.

But although we were short in places and men, we were long in initiative and technical knowledge—thanks to a small group of frightened and ill-treated men in the army and navy and in private industry. They were the men who, with inadequate appropriations and inadequate equipment, worked long hours to learn American aviation technology.

really ahead with, or slightly ahead of, other nations, during the years of conscious peace between World Wars I and II.

These men were often faced with the problem of deciding which important new project should be furthered because there were not sufficient funds to develop all the things that promised progress.

A case in point is interesting. It concerns the strong hands—the weapons

which has been used by the Nazis with destructive force against the civilian population of England and to some extent against American troops stationed there.

The first robot bomb—an unswidely looking flying machine—was developed in 1968 by the U. S. Navy and the Sperry Corp. It contained successfully, carrying 1,000 lb of TNT for 400 mi. But it was one of the inventions that our engineers had to ignore in favor of more important items—far in stance, our highly accurate bombhoppers which have made possible the precision bombing of enemy military targets.

That air engineers were wise, in their selection of new developments upon which to concentrate their energies and available funds, has been proved in aerial combat over many continents. American aircraft of this war—virtually all developed before Pearl Harbor—have time and again proved superior in design and performance. But the fact that we should have had to ignore other inventions which might have afforded us the power necessary for earlier victory is a lesson that America should not forget.

Despite inadequate funds, our engineers—both in the services and in private industry—were able to keep us ahead technologically so that, when we did come, the problem was not one of development but of quantity production.

Through their fearlessness they were also able to give us the edge—a phase of aviation which may well be one of the deciding factors of the war—the flexibility of design and engineering of our aircraft, permitting us to make constant improvements even while we were in mass production.

An example which shows the importance of peace time development, as well as abstinence from standardization, is the Boeing Flying Classroom.



"When we consider speeds of 400-500 mph, we want that 4-yr. payback," says Ray. In Bell's jet-propelled P-21 Scout, with auxiliary heating (thermal-jet engine) still in early development, burning refinery kerosene, price is \$100,000, says Ray. (AV/ATC editor)

## AIR POLICY POINTS FOR PEACE

1. Maintain the Army and Navy Air Force at the strength and technical proficiency necessary to provide a successful attack on ourselves or our possessions.
2. Facilitate the growth of an adequate private aircraft manufacturing industry through a planned Air Force replacement and development program, working through engineering competition, calculated to promote technical leadership and provide the capacity for emergency expansion.
3. Foster economically sound private

domestic and foreign air commands, utilizing the technical program of the armed services to reduce operating costs, improve service, and thus recover the costs of Air Force technical research.

4. Develop a system of shortcuts, always, aids to navigation, and facilities for the use of the Air Force, Air Command, and personal flying designed to increase the utility of the airplane.

3. Encourage young men and women to study economics, learn to fly, and acquire aviation's spirit and traditions.



This shot of smoke-scented rollout of North American B-25 Mitchell, during Wright Field test, is substantiating evidence that it is a safety possibility that within a short time, our bombers—and after the war, our airplanes—will be able to take off in half the space now required.

The B-17 made its first experimental appearance in 1935—more than five years before the war embroiled America. It was then ahead of its time, but in the ensuing five years, hundreds of improvements have been made on the big ship despite the fact that it was in mass production.

Early Fortresses had a maximum speed of 254 mph, at 14,000 ft. Armament consisted of five .50-cal. machine guns, and maximum weight was 34,000 lb. Today, the B-17 does considerably better than 300 mph, and it is protected by 12 to 16 machine guns, most of them mounted in power-driven turrets and fired with automatic coupling sights. Maximum weight is about 65,000 lb.

This plane is only one of the aerial weapons developed in peacetime years and used by this country in the present war. Work on the Boeing B-29 Superfortress was started in 1939. And the Republic P-47 Thunderbolt, North American P-51 Mustang, and Lockheed P-38 Lightning are just pre-war fighters.

Thus, had it not been for civilian research and development, we might not be waiting for a really effective World War II airplane. As it was, it took us almost a year, with virtually unlimited aircraft production appropriations, to get sufficient military aircraft into the field to initiate bombardment missions against enemy-occupied Europe.

The first heavy bombardment ap-

pearance against Nazi installations in France (Aug. 17, 1942) was flown by 12 Flying Fortresses; contrast that raid with the formations of thousands of bombers and fighter escorts which we are now sending daily against Hitler's inner fortress.

Since the outbreak of war, we have had adequate funds for research and development, and, making effective use of the facilities brought with these funds, our engineers have gone ahead with many improvements which are just beginning to be felt in aerial combat. And we may look for more surprises for the future.

#### Progress Reported

Some wartime developments of the AAF Materiel Command, now headquartered in the Air Technical Service Command, have been concerned with—

... Improvements in carburetors, carburetors, permitting use of alcohol as fuel, which gives them superiority over the enemy. The importance of this development to commercial aviation is great, since operation of passenger and freight carriers at sub-atmospheric levels for all-weather flying safety and comfort has long been a goal.

... Pressurized cabins, which permit B-29 crews to fly and fight with much greater efficiency than is possible with cumbersome protective equipment and oxygen masks. The positive commercial passenger will derive the same

of pressurized cabins while traveling in the sub-atmosphere.

... Jet propulsion, a development just beginning to be a factor in military aviation. Its potentialities, as in commercial uses are enormous, and not yet sufficiently clear to make definite predictions, for we do know that further increases in aerial speed lie in that direction. The propeller-powered plane has about reached the limit of its speed, because propeller-stall air speeds tend to disintegrate at the onsets of the blades approaches the speed of sound.

There is no such limitation as jet-propelled planes, and when we consider speeds of 600-800 mph, we must deal with jet propulsion. This focus of future power will probably be an important factor in filling post-war needs for high-speed flight.

Rocket-actuated takeoff and the variable-pitch propeller would seem to have a more immediate potential commercial importance. The RP propeller is now the subject of an intense study which has already led to great success in this field. It is entirely possible that within a short time, our bombers—and after the war, our airplanes—will be able to land and takeoff in half the space now required. Obviously a limiting factor in increasing the size and carrying-capacity of aircraft is the increased length of runways required. The quicker takeoffs with rocket assistance and "braked" landings with reversible pitch props may remove all limitations.

We are now working on bombers of size, range, load capacity, and armament far beyond anything we have. The same applies to transport with regard to range and capacity, being suitable that transport versions of the B-29 Superfortress and B-24 Liberator are already in production.

Concomitant with these efforts, work developing better power plants—then working toward more power with less weight—and better fuels for more efficient performance. Propeller designs are also being advanced, and we are seeking cleaner aerodynamic lines for greater lifting power for wing surfaces.

Air power because of speed and mobility, has emerged in this war as the first line of both defense and attack. It can carry the war to within a few miles (virtually) of important enemy installations—on a comparatively low (horizontally) requires months of intense and bitter fighting on the part of ground forces. It is not considered that air power alone can smash the axis defense system. That requires the help of the infantry.

But the importance of air power as a sub-

ing force, while concurrently we are developing necessary new and supplies for large scale land operations, cannot be overemphasized.

It is determined to remain in the air and ultimately prepared after this war. It is unreasonable that we should arm 11,000,000 of our men, and for protective postwar effort, to be so grossly out of balance. As we recently suggested, the best preparation will probably be to maintain a vigorously well standing army and naval force backed by a particularly strong reserve.

It is probably well to maintain, as a matter of fact, in a suitable air force, our power would give us time to make our ground forces in the event of an attack should again be attacked. It is not suggested that we maintain an air force so large as that we now have in the midst of this greatest war. But to do so would be an undesirable drain on national economy. But we are now working and developing to keep going at full pace. We must

have adequate appropriations for maintenance of the work that is going on at Wright Field, and we must provide private industry with sufficient orders for new types of aircraft so that this industry will always be in a position to quickly convert to military and naval aviation production should war again be thrust upon us.

Thus, an efficient and adequate engineering and research organization, backed by an aviation industry which keeps abreast of all new developments, should be the nucleus of our air power, which in turn should be the nucleus of our national defense.

By keeping ahead of other nations in the development of new aerial weapons, we can go a long way toward preventing war, for any aggressor nation would know it was being held back by our lead.

The importance to commercial aviation of such research and experimentation is obvious from the examples of war-born innovations previously cited, which will undoubtedly be adopted for

postwar passenger and freight transport.

At Wright Field, we have what is probably the most extensive aeronautical research and development establishment in the world, with the finest equipment and most outstanding complement of skilled personnel. To fail to take advantage of this setup, to advance peacetime aviation and protect America against future wars, would seem to be the height of folly.

We must remember that the aircraft industry is probably the most rapidly advancing business in the world. Designs which would have been considered fantastic dreams 10 or 20 years ago are now realities.

#### Quoted Testimony

The following quotations may help to illustrate the point:

"Every nation at war uses the best equipment that can be obtained. Improvements must be made continuously or one of the hostile forces will soon be outmoded by its opponent. . . . The 175 mph. pursuit plane in use now undoubtedly will be replaced by a 200-mph. plane within a few years. Similarly, a better bombing plane surely will make its appearance before long. It probably will be able to carry a 2,000-lb. bomb load and cruise at 100 mph. for over 8 hrs."

Does that strike you as funny? It was written in 1925, only 18 yrs. ago, by a man who was making a bold prediction—Henry H. Arnold, major, Air Service, U. S. Army, now C. G. of the AAF.

In the same book in which he made that statement, Gen. Arnold said:

"The next war between great powers probably will start with a horde of aircraft arriving unheralded over strategic points. Anti-aircraft guns will bark their protest from the ground and airplanes will rise to give battle and drive the invaders from the sky. Incendiary . . . and demolition bombs will destroy . . . concentration centers and maintain batteries; but, following procedure, the largest and best equipped air forces will be victorious."

Does this sound a bit like a prediction of Pearl Harbor?

These quotations are cited to show that our military leaders have not been unkind of probable advancement to be made in aviation, of the destructive uses to which these advancements might be put. But, by and large, the kind of advancement of these uses were only brushed aside. They were regarded as non-prophets. Meanwhile appropriations for military aviation have been steadily increasing.

May we never again let the first sight of such rank go unheeded!



Highly designed propellers are important to accurate target attack in ATSC Wright Field laboratory and device of speeds for exceeding those developed in flight with many other factors. Conditions simulated for test. Recent developments, the reversible-pitch propeller, is one of the subjects of intense study and promises to be of positive commercial importance.

# THE COMING COMPETITION IN FOREIGN MARKETS

PART II OF A SERIES

By **RAYMOND L. HOADLEY**, Financial Editor, "Aviation"

True enough, some luscious plans are ripening out in the export field. But they aren't going to fall right into the contract basket. To get them will require skillful plucking featuring the adroit use of every proven experience of the art—for the veteran foreign rivalry will be plenty stiff.

**A**IRCRAFT MANUFACTURERS should plan their export markets now if they want a larger share of the world trade than they had before the war. The markets are there—but it won't be just a case of moving in after reconstruction.

Agenda should be sent out to select the representatives wanted in foreign countries. There are, for example, concerns all over Latin America, which, having hangars and repair shops, are anxious to get Frenchmen to handle American aircraft and transport. American organizations should take the opportunity to pick the cream of the crowd while they can. When cancellations come in, it may be too late.

A manufacturer may argue that he's not busy with war orders that he hasn't yet been able to drain his production facilities. That may be, but accepting the initial promise that he is going to make a plane postwar, he should then take a tip from the automobile people. The latter don't know when they can resume car production or what their prices will be, even so they are building their export media against the time when merchandise can be sold.

One big reason for the industry's complacency regarding foreign trade is the fact that countries in all corners of the world are looking to America right now for transport aircraft. The resultant airframe market is transport planes may continue indefinitely. But it wouldn't surprise some astute export men if we all wake up some day morning to find that the British are way out ahead of us on personal plane exports. And the volume of personal plane sales eventually will far outdistance that of transports.

There is every reason to believe that

Great Britain will provide real competition for the American plane maker. You can't write off as a competitor a nation that has 15,000 firms making 2,000 aircraft a month. As Sir Frederick Handley Page has pointed out, an enormous effort has been spread about that British engineering "to close up the converted cinema, disused stables, and adapted Old Tom Shoppes."

Great Britain has to double her post-war exports in order to survive. She is going to be aided by large loans and credits from the United States. And it is fair to assume that she expects to utilize her vast wartime aircraft industry to increase exports.

Britain especially has her eye on untapped Latin American with its \$3,500,000,000 in trade balances. Already the lower East of South America—that is to say Argentina, Paraguay, and Uruguay—is in the British trade orbit. Exporters who have crashed up and down the coast of South America report that they found British agents everywhere, all patiently explaining why they haven't been able to make shipments during the war and following up by making arrangements for postwar shipments. The British government has expedited passports and visas for hundreds of commercial travelers who have already left England to sell British goods as soon as they are available for export.

The British are old hands at foreign trade; it has been a major source of livelihood for them. Those British agents have been exempt from the draft, whereas we yanked home commercial representatives of draft age. And in these desperate times, British plans to give priority to the military men who export to enter foreign fields.

Steps recently taken in London included the appointment of businessmen involved abroad as marketing officials in principal countries. Small firms used to send their own men will be represented by group agencies. The Department of Overseas Trade has made a survey in 25 countries outside of European battle areas for the "Boerish" drive. The surveys are laid up to date, hence all that will be needed on V-R Day will be cables setting out last minute instructions.

All the same time 140 English exporting industries have been organized for the quickest possible crash launch after the war. British officials fear that trade will no longer be purely a national concern and that industries not used to be competitors will have to work together in a team under government control to plan export production to meet the needs and demands of overseas markets.

The need for new products, high quality in old products, subliminal reliability, prompt delivery, and intensive use of the overseas and credit system, in having increased and been exporters by their government. Furthermore, these will be distributed in the United States and elsewhere to make sure the products are available for export whether or not the domestic demand is satisfied.

That accent on giving the export market priority on most postwar production is an important point for aircraft makers to consider. Foreign trade has always held a secondary position in the American scheme of things. Moreover, there will be much pressure after reconstruction to take care of the domestic market first, and this lot of "selling begonia at home" press will be strenuous just as it will in transportation. And still that the foreign market has to wait, consequently no other countries may step in to seek away our golden opportunity.

The Canadians are already seeing the Latin American trade through the disposal, south of our border, of surplus planes. Remember that Canadian plane production has increased from 900 in 1940 to around 4,000 in 1944. It is even possible she will export American-design airplanes built in Canada.

the past to the special requirements of each foreign market, especially regarding quality of products, selling systems, and payment terms. Revere G. Sanders, assistant vice-president of Fairchild Camera & Instrument Corp., who in a recent trip talked to business and government officials of nearly every Latin American nation, found definite resentment against American manufacturers and export organizations because they were prone to making "cash on the barrel head" demands before their merchandise left the wharves here.

Mr. Sanders believes that if we cannot get and hold foreign trade we must cut our credit up to six months, or a year if necessary, even though our customers have the money to pay. He explains that the Latin American businessman operates under the philosophy that it is a reflection on his integrity if someone refuses him credit.

Before the war, points out Mr. Sanders, we would demand irrevocable letters of credit with an order, without making any effort to take into account our customers' methods of doing business. At the same time, an export trade was built up in South and Central America by the Germans, who did accept the loose definitions in operation.

national methods and thereby profited. Companies considering their export operations as of little importance, should either not undertake them or should name experienced export agencies to care for what trade they have. Export handled loosely spells trouble. Deals initially negotiated by junior officers have frequently been turned down later by senior officials, and obviously this is bad business. All basic policy decisions should be reached at home before sending representatives abroad.

War conditions have often made it impossible for senior officers to visit foreign customers. But with the expected plane overruns now in prospect, senior officers should plan to do some traveling abroad in order to get firsthand impressions of the countries and the people with whom they want to deal. Certainly the foreign competition will be "in the half" in this respect.

Next month Mr. Hoadley will conclude this series foreign-trade series with an article detailing both practical working suggestions and government aids available to help American aircraft companies establish themselves in the highly promising export field.



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### The Yearbook photos—

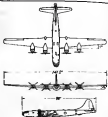
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**Boeing B-27 Superfortress**

World's outstanding bomber. It carries heavier bomb load greater distance than any other craft. Pressurized cabin permits extended high altitude

operations; control fire control system gives maximum defense. Also produced in quantity by Bell and Martin companies, to be built by Douglas and Lockheed.

**Boeing B-17E Flying Fortress**

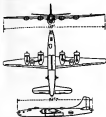
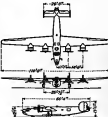
Armament, minimum of 13, 30, 40, machine guns; gross weight, 40,000 lb.; bomb load ranges up to two tons; high speed, over 300 mph.; service ceiling, over 35,000

ft.; range, up to 5,000 mi. This also been produced in large numbers by Douglas and Lockheed. Powered by four 1,200-hp. Pratt & Whitney Cyclone 9's.

**Consolidated-Vultee B-24J Liberator**

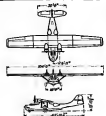
Armament consists of at least ten 50-cal. machine guns; gross weight, over 30,000 lb.; high speed, over 320 mph.; service ceiling, over 30,000 ft.; range,

over 5,000 mi. Powered by four turbo-supercharged Pratt & Whitney. Now being produced under license exclusively by Ford at Willow Run plant.

**Consolidated Vultee PB4T-2 Liberator**

Single (all Navy) modification of basic B-24 design with added structural and gross weight increasing 12,000 lb. Used on north pacific, which means

fighting way through very deep opposition to bomb shipping or shore installations. Powered by four 1,200 hp-plus Pratt & Whitneys.

**Consolidated Vultee PB4T-2 Liberator**

Amphibious version of basic design first put in service in 1945. Has given Navy outstanding service, being used in everything from cargo lugger to troops

bomber. High speed, 118 mph.; gross weight, 30,000 lb.; range, over 5,000 mi. Powered by two 1,200-hp. P & W. Also has been widely used by RAF.

**Consolidated Vultee PB4T-2 Liberator**

Armament, minimum of six 50-cal. machine guns; gross weight, 40,000 lb.; high speed, 300 mph.; range, over 5,000 mi.; service ceiling, 30,000 ft. Pre-

ced by four 1,200-hp. P & W. Has served both as patrol bomber and as cargo carrier with Naval Air Transport Service throughout Pacific.



**Consolidated Vultee A-24 Vengeance**

Armament: low mid-wing dive bomber powered the British in 1940. High speed, over 320 mph., range, 1,500 mi. Also powered by one 1,200-hp.

Wright Cyclone 24 Blended dive bomber in shape with wing for normal flight, swing out from both surfaces to show speeds in dive approaching the target.

**Curtiss SB2C Helldiver**

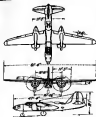
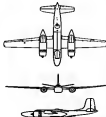
Armament, machine guns or 24 inch cannon on wing and tail. SB2C is now obsolete. High speed, over 340 mph., cruising speed, 250 mph., range, 1,500 mi., serv-

ice ceiling, 25,000 ft., bomb load of approximately 1,500 lb., carried within fuselage. Powered by one 1,700-hp. Wright 14 Photo shows Army A-22 version.

**Douglas A-26 Invader**

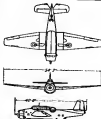
Said to be one of world's most versatile planes. Armament may be varied according to operations; bomb loads are said to be unusually heavy for craft of its

size. High speed, over 375 mph., gross weight, 20,000 lb., plus. Powered by one 2,000-hp. Pratt & Whitney. A battle-development of famed A-24.

**Douglas A-29 Havoc**

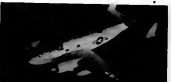
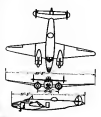
Powered armament varies between 50-cal. machine guns and 20 inch cannon or cannon. One—said 50's are used in rear turret. High speed, over 320

mph., gross weight, 20,000 lb., range, 1,000 mi., service ceiling, 20,000 ft. Powered by one 1,825-hp. Wright R-2600 Cyclone 14's. Also serving RAF.

**Grumman TBF Avenger**

Armament, multiple 50-cal. machine guns firing forward, power dorsal turret, and ventral gun turret; gross weight, approximately 22,000 lb., range, 1,500

mi., high speed, about 275 mph., service ceiling, over 20,000 ft., power, 1,700-hp. Wright. Bomb load carried laterally. Also serving aboard British carriers.

**Lockheed B-24 Liberator**

Armament, 50-cal. machine guns in nose, power dorsal turret and ventral turret; gross weight, 30,000 lb., range, 1,500 mi., high speed, 340 mph., serv-

ice ceiling, 20,000 ft., power giant, two 2,000-hp. R-2800 P & W's. Also used extensively by Navy as coastal patrol work under P-1 designation.

**North B-24 Liberator**

One of world's heaviest armed medium bombers. Gross weight, 35,000 lb., range, over 1,000 mi., high speed, 320 mph., service ceiling, over 24,000 ft., powered

by two 2000-hp B-24 Pratt & Whitney. In addition to all types of land operations, has also served as tactical bomber in Pacific theater of operations.

**North P-51 Mustang**

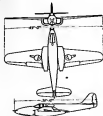
Armament, 10-cal. machine guns in nose, dorsal and tail turrets; gross weight, 56,000 lb., range, over 3,000 mi., high speed, 320 mph., service ceiling, over

35,000 ft., powered by two 1,700-hp. Wright Cyclones. Also widely used as superb aerial scout. P-51's designation, Bomber escort crew of B-12.

**North American B-25 Mitchell**

Armament ranges up to 14 50-cal. machine guns and one 35 mm. cannon behind bomb load. Gross weight, 22,000 lb., weight empty, 12,480 lb., high speed,

over 300 mph., at 14,500 ft., service ceiling, 23,500 ft. Powered by two 1,700-hp. B-2500 Wright Cyclones. B-25's common version also used by Marines.

**Bell P-39 Airacobra**

America's first jet-propelled plane, this fighter is powered by two Whittle-type gas turbines developed and produced by General Electric. All performance

data is restricted, but speed is in excess of 400 mph. Ceiling is over 40,000 ft. Armament consists of at least four 50-cal. machine guns.

**Bell P-40 Warhawk**

Armament, 27 mm. cannon firing through propeller hub, and four 50-cal. machine guns; gross weight, 8,100 lb., range, over 1,000 mi., high speed, 400 mph.

plus, service ceiling, 35,000 ft. Powered by 1,500-hp. Allison V-1710. Developed from P-36 Airacobra. Large part of production has gone to Russia.

**Curtiss P-40 Warhawk**

Armament, six 50-cal. machine guns; gross weight, 9,500 lb., range, 1,500 mi., high speed, over 300 mph., service ceiling, 35,000 ft., service ceiling, 35,000 ft.

600 ft. Powerplant, 1,500-hp. Allison V-1710. Model Q, last of this famous line, has Pratt & Whitney R-2800. C-77 has built 15,000 of P-40 series.

**Brewster F2F-1 Buffalo**

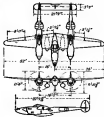
Armament, six 50-cal. machine guns in wings; gross weight, approximately 7,500 lb.; high speed, over 340 mph; service ceiling, 22,000 ft. Powered by

2,000-hp. Pratt & Whitney R. 2800. Drop tanks give range of 1,200 mi. First carrier fighter to be designed on basis of combat experience.

**Lockheed P-52 Lightning**

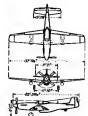
Armament, four 50's and one 20-mm cannon mounted in nose; gross weight, up to 15,000 lb.; weight empty, 13,700 lb.; range, 750 mi.; high speed, over 400

mph; service ceiling, 35,000 ft. plus. Powered by two V-1710 turbo-supercharged Allison giving 1,550 hp. to 27,000 ft. Performance version designated P-5

**North American P-51 Mustang**

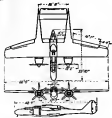
Armament, six 50-cal. machine guns or four 30-mm cannons, as combinations; gross weight, 8,000 lb.; high speed, over 400 mph; service ceiling, 40,000 ft.

plus; power plant, Packard-built Deltic Super Merlin delivering 1,600 hp. at 14,500 ft. One of the world's top fighters. It has doubled as dive-bomber.

**Northrop P-41 Black Widow**

Four 50-cal. machine guns in power turret, underslung gun bar of 50 mm. cannon make this night fighter one of best in class of such craft. Gross

weight 20,000 lb.; high speed over 350 mph; landing speed, 50 mph but can be flown on two. Power, two 2,000-hp. plus Pratt & Whitney Double Wasps

**Republic P-47D Thunderbolt**

Armament, eight 50-cal. machine guns; gross weight, over 14,000 lb.; range, 1,000 mi.; high speed, over 420 mph. at 25,000 ft.; service ceiling, 38,000 ft. Pow-

ered by turbo-supercharged R. 2800 Pratt & Whitney two row radial, water injection system of over 5,000 hp. Also doubled as dive bomber and ground strafing

**Vought P-50-10 Corsair**

Armament, six 50-cal. machine guns; range, 1,500 mi.; high speed, over 400 mph; service ceiling, over 35,000 ft. Powered by 2,000-hp. Pratt & Whitney

R-2800 Double Wasp. Used as both land and carrier-based fighter. Also produced by General Aircraft Corp. as FG-1. Designed as bomber.



**Boeing 48-43 Traveler**

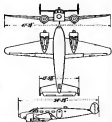
Popular private personal craft put into military service as personnel carrier where swift movement is necessary. High speed, 202 mph at 5,000 ft., cruising

speed, 173 mph. at 5,000 ft., range, 520 mi., service ceiling, 24,500 ft. Powered by one 600-hp. Pratt & Whitney engine producing 260 hp. Jumbo L-10

**Boeing 48-45A Expediter**

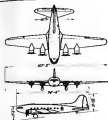
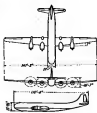
Military version of type to be modified for postwar ferry-like operations with five to six passenger capacity. High speed, 221 mph., cruising speed, 194

mph., gross weight, 7,500 lb., weight empty, 5,025 lb., service ceiling, 21,500 ft., initial rate of climb, 1,850 fpm. Powered by two 420-hp. P & W's.

**Boeing 6-17 Stratocruiser**

Fastest transport based on B-20 Superfortress design, with passenger capacity ranging from 10 to 300. High speed, 400 mph., cruising speed, 340 mph., gross

weight, 120,000 lb., weight empty, 70,000 lb., normal range, about 2,500 mi. Power, four 2,200 hp. Wrights, for emergency record of 5 hr. 4 min.

**Boeing 3A 307B-1 Strato-liner**

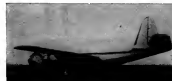
Fastest passenger luxury liner being rebuilt for TWA, using B-17 wings, powerplants, landing gear and tail section. High speed 325 mph. at 15,000 ft.,

cruising, 225 mph. at 15,000 ft., service ceiling, 22,000 ft., range 1,500 mi., gross weight, 54,000 lb. Power, four 1,200-hp. Wright Cyclone six's.

**Boeing 324 Clipper**

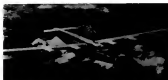
Transoceanic flying boats serving Panama and Government operated all British Overseas Airways in worldwide operations. High speed, 210 mph., cruising speed,

180 mph., range, 4,500 mi., gross weight, 54,000 lb., weight empty, 46,100 lb. Maximum load, 80 passengers. Power, four 1,800-hp. Wright Cyclones.

**Budd 3B-1 Condor**

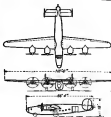
Winged cyclone and cargo carrier with 8 x 8 by 25-ft. unobstructed space within fuselage over landing door. Designed to take off with full load

to 600 ft. Gross weight, 33,500 lb., payload, 20,400 lb., cruising speed, 185 mi., normal range, 600 mi., maximum range, 1,200 mi. Power, two 1,500-hp. P&W's.

**Consolidated Vultee C-47 Liberator Express**

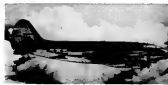
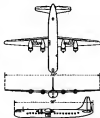
Military cargo-passenger transport version of B-24, used extensively on Burma-China run over Himalayan "Hump." High speed, over 320 mph, cruising

speed, over 300 mph, gross weight, over 60,000 lb., range, approximately 4,000 mi. Powered by four turbo-supercharged 1,500-hp. Pratt & Whitney.

**Consolidated Vultee Liberator Door**

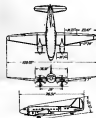
Of 46-52 passenger capacity, this door is built around B-24 wing, power plant and landing gear. High speed, over 300 mph, at 13,500 ft., cruising

speed, over 300 mph, at 10,000 ft., gross weight, 60,000 lb., weight empty, 30,000 lb., maximum range, over 3,000 mi. Power, four 1,200-hp. P & W's.

**Curtiss C-46 Commando**

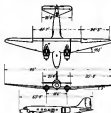
World's largest twin engine transport, used in every war zone. High speed, over 300 mph, at 15,000 ft., cruising speed, 257 at 13,000 ft., service

ceiling, 24,500 ft., range, 1,000 mi., gross weight, 45,000 lb., weight empty, 20,000 lb. Power, two 2,000-hp. Pratt & Whitney Double Wasp.

**Curtiss CW-38 Commando**

Postwar commercial version of C-46, seating 30-42 passengers, on which Eastern and National have placed orders. Redesigned nose and pilot's cabin is major

airward change, but others have been made throughout to adapt plane to postwar specifications on airliners. Now version to be powered by 2,000-hp. Wrights.

**Douglas C-47 Skytrain**

Military version of famed DC-3, most widely used transport in world. High speed, 320 mph, at 8,500 ft., cruising speed, 305 mph, at 10,000 ft., service ceiling,

24,100 ft., range, over 2,000 mi., gross weight, 30,000 lb., weight empty, 20,000 lb. Power, two 1,000-hp. P & W's. Also has been used in glider tow craft.

**Douglas C-54 Skymaster**

Widely used cargo-passenger transport familiar in every part of world. High speed, 360 mph, at 18,500 ft., cruising speed, 330 mph, at 13,000 ft., service ceiling,

30,000 ft., gross weight, 72,000 lb., weight empty, 30,000 lb. Powered by four 1,600-hp. B-5000 Pratt & Whitney. Max range of over 3,000 miles.

**Douglas DC-4**

Fastest version of fastest C-54 derivative which will be used in trans-ocean as well as domestic operations. Several major American airlines have already placed orders on this

and DC-6 type totaling more than \$150,000,000. Orders call for production as soon as war conditions permit resumption of export for civilian uses.

**Douglas DC-4**

Developed from basic design of C-54 and DC-3, this type has also been ordered in quantity for delivery as soon as conditions permit production. High speed, 254 mph., against

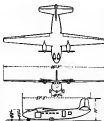
250 of DC-4; cruising speed, 219 vs. 220; passenger capacity, 38 against 40; gross weight, 50,500 lb., against 51,500; range, 2715 vs. 2,610.

**Douglas DC-7**

Large postwar transport already ordered by at least one major airline. Gross weight, 160,000 lb., passenger capacity, up to 118; range, over 4,000 mi.; high speed, approximately 400 mph.; powerplants, four P-50 Wasp Majors.

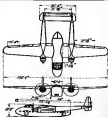
**Douglas Skyline**

Designed for faster line operations, seating 54 passengers. Gross weight, 17,500 lb., cruising speed, 300 mph., landing speed, 80 mph., normal range, 600 mi., wingspan, 66 ft. 7 in. Will be powered by two 700-hp. piston engines.

**Fairchild C-42 Packard**

Cargo, passenger, ambulance and having 2,275 cu. ft. of cargo capacity, room for 42 troops, or 84 officers and four attendants, plus military

crew of five. Gross weight, 42,000 up to about 50,000 lb., weight empty, 26,500 lb. As these would take 50 passengers. Power, two 2,000-hp. P & W's.

**Fairchild UC-41K Forwarder**

Reaper-powered military version of one of most popular personal planes. High speed, 154 mph., cruising speed, 112 mph., initial climb, 520 fpm., range 405 mph.

service ceiling, 10,100 ft., gross weight, 2,992 lb., weight empty, 1,812. Engines in 200-hp. inverted six-cylinder valves. Also used by RAF, designated Argos.

**Grumman J4F Goose**

Military version of G-21A, widely used by Coast Guard for harbor patrol and sea rescue work. High speed, 303 mph., cruising speed, 190 mph., initial

climb, 1,300 fpm., service ceiling, 20,000 ft., range, 1,900 mi., gross weight, 15,500 lb., weight empty, 8,500 lb. Power, two 400-hp. Pratt & Whitney.

**Grumman J4F Widgob**

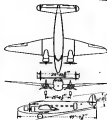
Provides place emphasis and especially as personal carrier in Navy. It is military version of popular personal plane. High speed, 154 mph., cruising speed,

150 mph., initial climb, 700 fpm., service ceiling, 15,500 ft., range, 775 mi. Power, two 200-hp. Engines. Model pictured has postwar color scheme.

**Lockheed C-68 Lodestar**

A 17-place military version of private airliner. High speed, 270 mph, cruising speed, 248 mph, service ceiling, 27,000 ft., range, 1,640 mi., gross weight,

18,300 lb. Optional power plants are either two 1,500-hp Pratt & Whitney Wasp or Wright Cyclones. Modifications used as navigation aids.

**Lockheed C-47 Constellation**

Designed as 60-passenger luxury liner, is now in military service. At least two military variants exist for postwar versions. High speed over 350 mph, landing

speed, 50 mph, service ceiling, 25,000 ft., gross weight 30,000 lb. Power plants are either two 1,500-hp Pratt & Whitney Wasp or Wright Cyclones. Prototype crossed country in 6 hr, 50 min

**North van Klee**

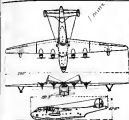
Both two and four engine designs of this type have been proposed for postwar passenger and cargo operations. Developed primarily for cargo work, both types have rear

loading facilities, aft end of fuselage swinging up and out of way so that freight may be loaded directly to craft for direct loading under boom and ramp.

**Lockheed Super 75**

Designed for short haul, high frequency schedule operation, this type has already been ordered by two operators. Passenger capacity is variable, from 8 to 14, depending on

engine load. Gross weight 6,000 lb., high speed, 360 mph, cruising, over 300 mph, speed, 78 mph, range, 1,000 ft. Power, 125-hp. Wright

**North 28M-1 Mary**

Standard cargo version of XP38M-1 which has continuously set new records. High speed, over 300 mph, cruising speed, in excess of 270 mph,

service ceiling, over 25,000 ft., range, over 3,000 mi., gross weight, 140,000 lb., plus, Power, four 2,000-hp. Wasp, Mary's utilization, 8.7 hr. per day.

**North Levittone**

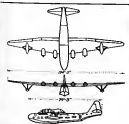
Designed for long range, narrow passenger transport unit, this six engine flying boat will have a gross wt. of about 24,000 lb. Passenger capacity is listed as 180, with

allowance for 80 lb. of baggage each, in addition to 25,000 lb. of cargo. Designed to have cruising speed of about 300 mph. Plane also can fly straight cargo version.

**North Mercury**

One version of tanker and short haul-passenger craft designed to carry up to 30 passengers (gross weight, 32,500 lb., weight empty, 23,500 lb., range, 500 mi., high speed,

315 mph, at 8,000 ft., cruising speed, 250 mph, at 10,000 ft., fuel capacity, 500 gal. Power plants, two 2,500-hp. P & W's. Other version of same basic design has high wing.

**Vought-Sikorsky VS-44A Brewster**

Serving American Export Air Lines on transatlantic service, holding flying boat speed records both ways. High speed, 325 mph, cruising speed, 275 mph,

service ceiling, 25,000 ft., range, 3,000 mi., gross weight, 37,000 lb., weight empty, 26,200 lb. Power, four 1,200-hp. Pratt & Whitney Twin Wasps.

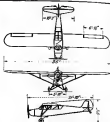
# AMERICAN LIAISON TRAINERS



**American L-3 Grasshopper**

One of the "mighty mites" which have given liaison service as utility planes, observation and rescue planes. Developed from postwar general plane de-

sign, has gross weight of 1,200 lb., range of 220 mi., high speed of 87 mph., cruising speed of 70 mph. and landing speed of 40 mph. Power, 65-hp. Continental.



**Beech AT-11 Kansan**

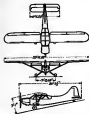
Developed from one of Beech's well-known executive type private craft, Kansan has been widely used as a bomber crew and instructor trainer. As identical craft powered by

two 450-hp. Pratt & Whitney Wasp J<sub>2</sub>'s, it has a high speed of 210 mph. at 5,000 ft., and cruising speed of 180 at same altitude. Climb at sea level is 1,130 ftm., service



ceiling is 23,000 ft. Fuel capacity is 120 gals., normal range is 560 mi. Gross wt., 6,121 lb., wt. empty, 6,156 lb. Phantom view above shows structural details and crew lo-

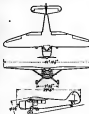
cations. Span is 47 ft. 4 in., length is 34 ft. 2 in., height 6 ft. 4 in. Wing area 240 sq. ft., wing loading 25 lb. sq. ft. Used by Army's 52ND S. bomber train-



**Stinson L-4 Sentinel**

Highest powered of the L-Jobs. It has a 130-hp. Lycoming engine giving a top speed of 123 mph., cruising of 117 with range of over 250 mi. Gross weight is

2,128; weight empty, 1,672 lb. Initial rate of climb is 1025 ftm. and service ceiling is listed as 15,500 ft. Phase section take off run, show landings for rough fields.



**Stinson AT-19 Sentinel**

A Stinson powered postwar plane modified for war service as advanced radio and navigational trainer widely used by HCAF and HAF. High speed, 141 mph.,

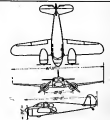
range 350 mi., fuel capacity 70 gals., gross weight, 6,000 lb., weight empty, 3,310 lb., service ceiling, 14,000 ft. Power, one 200-hp. Lycoming radial.



**Cessna AT-17 Bristle**

Twice engine liaison trainer which has also found wide-spread use as personnel carrier by HCAF as well as American Air Force. High speed, 165 mph., cruising

speed, 108 mph., gross weight, 2,700 lb., wt. empty, 4,300 lb., range, 360 mi., service ceiling, 25,000 ft., initial climb, 550 ftm., power, two 200-hp. Jacobs.



**Fairchild PT-19 Cornell**

Thousands of AAF pilots have received primary training in this type, as have HCAF and HAF pilots in dual cockpit version. High speed, 120 mph., cruising

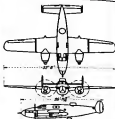
speed, landing speed, 52 mph., 115 mph., range, 400 mi., gross weight, 2,515 lb., weight empty, 1,250 lb. Power, 75-hp. Cyclone; simulated Bessie in line.



**Fairchild AT-21 Stearman**

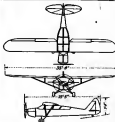
All-wood bomber-coach trainer in which teamwork which has meant so much for AAF bomber record has been developed. High speed, 210 mph, cruising speed,

194 mph. Gross wt., 11,292 lb., wt. empty, 8,627 lb., normal range, 750 mi. Powered by two 12-CTA, inline, air-cooled 450-hp. Engines.

**Stearade L-4**

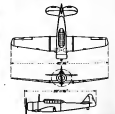
Military version of the former Cessna personal plane used for training. Extensive photo. High speed, 214 mph, all sea level, cruising speed, 195 mph, normal

range, 275 mi., fuel capacity, 50 gal., gross weight, 1,650 lb., weight empty, 1,300 lb., landing speed, 30 mph, service ceiling, 30,000 ft. Power, one 115 hp. Franklin.

**North American AT-6 Texan**

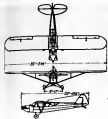
American Air Forces' most widely used advanced trainer, and standard for such work with several other national air arms. High speed, 208 mph, at 5,000 ft.,

cruising speed, 190 mph, range 750 mi., gross weight, 8,545 lb., weight empty, 4,100 lb. Power, 600-hp. Pratt & Whitney. Max service ceiling of 31,600 ft.

**Figure L-4B**

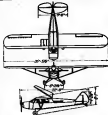
Found in some dispatches as Cessna crash carrier in all theaters. These little jobs have been taken in carrying soldiers for additional ground cooperation.

work. High speed 87 mph, cruising speed, 75 mph, landing speed, 35 mph, climb, 450 ft./min., gross weight, 2,225 lb., power, 40-hp Continental.

**Figure L-4**

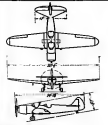
An ambulance plane developed from the basic Cessna design but with more powerful engines—a 200-hp. Landing—diving high speed of 110 mph at 5,000 ft.,

and cruising speed of 95 at same altitude. Landing speed, 40 mph. Gross and empty weights are 1,427 and 800 lb. respectively. Range 235 and 290 mi.

**Stear PT-26**

An all-wood primary trainer developed to avoid use of strategic materials during severe metal shortage. High speed 140 mph, cruising speed, 126 mph, range,

278 mi., gross weight, 1,800 lb., weight empty, 1,250 lb., service ceiling, 30,000 ft. One 100-hp. Landing—climb gives initial rate of climb timed at 1,500 ft./min.



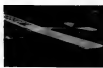
**Taylorcraft L-2**

Equipped with three power plants, 60 hp. Continental on L-2B; similarly rated Lycoming on L-2J; and by Franklin on L-2C. Specifications remain

constant, including high speed, 100 mph, cruising 60 mph, landing speed, 35 mph, service ceiling, 15,000 ft., range, 375 mi., gross wt., 1,000 lb.

**Stearman**

Design tandem, motor designed for racing and personal utility flying. High speed, 100 mph, cruising speed, 60 mph, landing speed, 35 mph, climb, 500 ft./min., capacity, 12 gal., cruising range, 275 mi., gross wt., 1,250 lb., useful load, 510 lb., max. speed, 130 mph. Will be powered a 50-hp. engine; also available with one for water-based operations.

**Aerocraft Chief**

Two-place tandem, motor designed for personal use as well as conditions present. High speed, 100 mph, cruising speed, 60 mph, landing speed, 35 mph, rate of climb, 500 ft./min., fuel capacity, 12 gal., 24 with auxiliary tank. Cruising range with auxiliary tank, 300 mi. Will have 50-hp. engine. Single-engine version to be available.

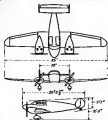
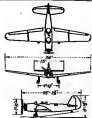
**Aerocraft Arrow**

Two-place all metal design with retractable landing gear. High speed, 100 mph, cruising speed, 120 mph, landing speed with flaps, 40 mph, without flaps, 54 mph, rate of climb, 550 ft./min. Fuel capacity, 25 gal., cruising range, 300 mi. W's empty, 850 lb., useful load, including 50 lb. of baggage, 900 lb., gross wt., 1,250 lb. 110 hp. aluminum engine.

**Thom HT-1**

All-wood primary trainer developed for Navy. High speed, 120 mph, cruising speed, 118 mph, normal range, 340 mi., fuel

capacity, 42 gal., service ceiling, 10,000 ft., initial climb, 1,000 ft./min., gross weight, 2,125 lb. Powered by one 200-hp. Continental.

**Aerocraft Chief**

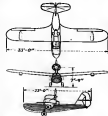
All-wood four-place craft developed for personal plane market. High speed, 120 mph, cruising speed, 117 mph, landing speed, 50 mph, normal range,

300 mi., fuel capacity, 38 gal. Gross weight, 2,500 lb., weight empty, 1,700 lb., initial climb, 600 ft./min., service ceiling, 13,000 ft. Power, two 100-hp. Franklin.

**Volvo HT-13**

One of A.A.'s most widely used basic trainers. All-metal craft having high speed of 140 mph, cruising speed of 140 mph, capacity, 120 gal., normal range,

216 mi., service ceiling, 17,000 ft. Gross weight, 3,300 lb., weight empty, 2,540 lb. Power, 400 hp. Ford & Whitney Tump Junior giving 600 ft./min. climb at sea level.

**Aerocraft Arrow**

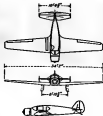
One of simplest personal airplanes, developed by Ray Applegate for power market. Gross wt., 1,200 lb., wt. empty, 1,000 lb., baggage allowance, 60

lb., high speed 120 mph, cruising speed 90 mph, landing speed, 35 mph, range 300 mi. Power, 60 hp. Franklin four-cylinder low blade, Red pitch wood propeller.

**Bellanca Crusader 14-P**

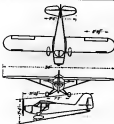
Three-place combination wood and metal craft in the \$8,500 class. High speed, 126 mph; cruising speed, 120 at one hour; service ceiling, 12,000 ft.; fuel

capacity, 20 gal.; normal range, 400 mi.; gross weight, 1,500 lb.; weight empty, 1,140 lb. Power: one 120-hp. Franklin. Features a retractable landing gear.

**Celler A**

Two-place craft of conventional design bearing AVO No. 154. High speed, 117 mph; cruising speed, 231 mph; service ceiling 12,000 ft.; fuel capacity,

25 gal.; normal range, 242 mi.; gross weight, 1,500 lb.; weight empty, 1,050 lb. Power: one 100-hp. Lycoming. Initial rate of climb, 710 fpm.; landing speed 45 mph.

**Commonwealth Bomper**

Two-place craft powered by 65- or 75-hp. Continental, latter giving high speed of 110 mph; cruising speed of 200; landing speed of 40. With 65-hp. engine range is 450 mi., with 75 is 430.

**Commonwealth Crusader**

Three-place plane designed for 65- or 120-hp. Sun-Rayco. With latter, high speed is 145 mph; cruising, 125; landing 60 mph; range 600 mi.; gross wt., 1,800 lb.; wt. empty, 1,320 lb.

**Culver Cadet**

High performance two-place craft, one of first personal planes to have retractable landing gear. High speed, 140 mph; cruising speed, 120 mph; service ceiling,

17,200 ft.; fuel capacity, 20 gal.; range 600 mi.; gross weight, 1,500 lb.; wt. empty, 800 lb. Powered by 80-hp. Franklin engine. Initial rate of climb, 600 fpm.

**Engineering & Research Corp. Kevscope**

One of nation's two side-by-side, two-seater airplanes, Kevscope is an all metal two-place craft. High speed, 117 mph; cruising speed 205 mph; service ceiling, 2,500

ft.; fuel capacity, 20 gal.; normal range, 425 mi.; gross weight, 1,500 lb.; weight empty, 725 lb. Power: 80 hp. Continental. Landing speed, 45 mph; climb, 700 fpm.

**Eshelman PW-4**

Left, for postwar private owner has Lycoming 240-hp. engine, top speed 180 mph; cruising 165; range 700 mi. Construction steel tube with fabric covering.

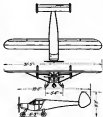
**Petrakoff M-24**

Andri's drawing of four-place plane "Petrakoff" plane, prototype of which is now being built. Production to begin, when materials are available.

**General GC-26 Skyfacer**

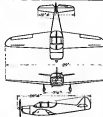
Second of America's two-seat, open-cockpit planes. Developed by General Aircraft of New Jersey, to be produced by Le Mans Aircraft as Skyplane; General

will produce other models post-war. High speed 200 mph, cruising 107; range, 400 mi.; gross weight, 1,550 lb.; wt. empty, 600 lb.; power 15-hp. Lycoming.

**Glush DC-1A Swift**

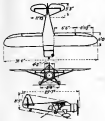
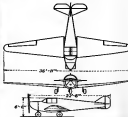
Revised version of earlier Glush Swift, designed for postwar production. Monocoque (leading gear); high speed, 155 mph, cruising speed, 125 mph, service

ceiling, 14,200 ft., fuel capacity 20 gal., normal range, 600 mi.; gross wt., 1,500 lb.; 40-hp. Continental Nine engine has all-metal fuselage, plywood wings.

**Gregg Rocket A-75**

Two-place, all-metal semi-monocoque construction craft, with fixed tricycle landing gear. High speed, 146 mph, cruising speed, 130 mph, service ceiling, 12,000

ft., fuel capacity, 18 gal., normal range, 440 mi.; gross wt., 1,302 lb.; wt. empty, 734 lb. Power, 15-hp. Continental. Landing speed, 42 mph.; climb, 600 fpm.

**Howard PGA-15P**

High performance personal plane also used by Army and Navy for fast personal carrier. Cruising speed, 130 mph, initial rate of climb, 1,600 fpm, service

ceiling, 21,500 ft., fuel capacity, 120 gal., normal range 550 mi.; gross wt., 4,250 lb.; wt. empty, 3,008. Powered by 400-hp. Pratt & Whitney Wasp Junior.



Maugh N-32 (left), proposed three-place personal craft to have 102-mph. high speed; 140 mph, cruising speed; range 450 mi. Power, one 90-hp. Lycoming.

Lozcombe S8Dixie (above) on which production is to be resumed. High speed 115 mph, cruising speed, 200; range, 470 mi. Power, Continental 75.

**Maugh Mercury**

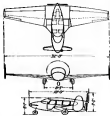
All-metal two-place light-plane with 145-mph. high speed, 120-mph. cruising speed and 45-mph. landing speed. Fuel capacity, 16 gal., range 480 mi. Gross wt.,

1,350 lb.; wt. empty, 610 lb. Climb, 1,500 fpm, service ceiling, 20,000 ft. Power, 70-hp. Lycoming. Fuselage is stressed skin monocoque construction.

**Republic H-4**

Forward four-place canopy type designed for postwar production. Built around standard "Ford" extending from nose aft to form engine mount and

propeller shaft mount. To have 120-hp. Lycoming six engine giving high speed of 180 mph., cruising speed of 170 with range of 520 mi.

**Republic Thunderbolt Amphibian**

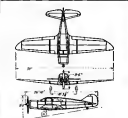
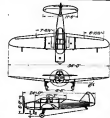
Three-to-five place postwar craft designed to sell for less than \$4,000. To be powered by engine in 175-hp. class, giving high speed of 180 mph., cruising of 160.

Gross wt. to be about 2,000 lb., range of 520 mi. Landing speed 50 mph. Production model to be all metal with output scheduled upon availability of components.

**Pylon PT-3**

Prototype has been built and test flown; firm is expected to be available postwar for training and personal use. High speed, over 250 mph., cruising 185 mph.

landing speed, under 70 mph., climb over 100 ft./min., fuel capacity, 40 gal., service range, 700 mi., gross wt., 2,000 lb., wt. empty, 1,200 lb. Power, 120-hp. Franklin

**Sparhawk Executive**

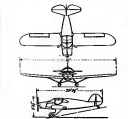
High performance two-place craft used by military for personal transport. High speed, 310 mph., cruising 230 at 6,000 ft., fuel capacity, 310 gal., range,

1,500 mi. Power, 600-hp. P. & W. Improved version of this model is being studied for postwar production. Sparhawk plans to build a twin engine personal plane.

**Pylon J5-C Cub Coupe**

One of aviation's most popular prewar two-place personal planes. Powered by 120-hp. Lycoming, has top speed of 130 mph., w. 5,000 ft., cruising speed of 90 mph., at

same altitude; climb of 800 ft./min. and service ceiling of 12,000 ft. With 30 gal. fuel capacity, range is 200 mi. Forward version to be produced as soon as possible.

**Stearman Ariel**

Designed for 75-hp. Continental or 80-hp. Franklin. With later installation, has 127-mph. high speed, 112 mph. cruising speed, 45-mph. landing speed; 1,000 ft./min.

initial climb and service ceiling of 17,000 ft. Fuel capacity, 20 gal., range 420 mi. Gross wt. 2,300 lb., wt. empty, 900 lb. Also other designs around Lycoming.

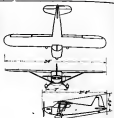
# AMERICAN PERSONAL



**Stearman Voyager 125**

New and larger version of popular 100, three-view of which is shown at right. This model has high speed of 108 mph, cruising

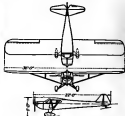
of 112 and landing speed of 31 mph. Gross wt., 1,875 lb., wt. empty, 1,315 lb., wings, 410 sq. ft., power, 122-hp. Landing gear, fixed.



**Taylorcraft Model B-15**

Four-place "family" craft designed for postwar production to sell in the \$4,000-class. With 130-hp engine, high speed is 125 mph, cruising speed 132; landing

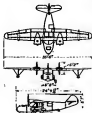
speed 40. Fuel capacity, 38 gals., gross wt., 2,550 lb., wt. empty, 1,275. Model has doors for both front and rear main passengers. Three-view shown B-15.



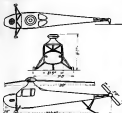
**Trimmer Amphibia**

Designed for postwar market to sell under \$4,000. All wood construction. 5-place craft having high speed of 125 mph, cruising speed of 118 and service ceiling

of 12,500 ft. Gross wt., 2,200 lb., wt. empty, 1,200 lb., wings, 260-330 sq. ft. Power, two 85-hp. Continental. Landing speed is 48 mph, rate of climb, 700 fpm.



# AMERICAN HELICOPTERS



**Aeromedical Products Model 34**

Two-place craft using standard engine, mounted in front to save production costs and facilitate maintenance. High speed, 100 mph, cruising speed, 80

mph, climb, 1,100 fpm, service ceiling, 11,000 ft. Main rotor blade material, steel, 550. Power, 65 hp. 6-cylinder 100-hp. Franklin.



**1st**

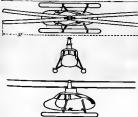
First laboratory incorporating a turbine developed by the Army, who broke Bell's longer development program, being ten years ahead of Bell and development work.

One outstanding difference from other rotary wing craft is use of stabilizing bar on right angles to make two-blade rotor, which is of solid wood construction incorporating steel



most in landing edge. Main rotor blade has 22-in. diameter; main rotor has 1-ft. diameter. Fuselage is of tubular section with metal and fabric covering with side-by-side

seating for two. This model is powered by a 100-hp Franklin engine, but is being designed for use of various landing gear are full covering.



**Bendix Model G (left)**

Under development, five craft will have 100-hp. High speed, 100 mph, cruising speed, range of 200 mi. To be powered by 100-hp. Warner. Gross wt., 2,000 lb.

**Bendix Model H (above)**

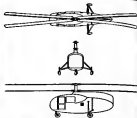
To be powered by 100-hp. engine, this model is now under development as a freight carrier, but is being designed for easy conversion for passenger use.

## AMERICAN HELICOPTERS



**Beech Model 1**  
Four-place co-axial rotor  
type, new under development.  
Continental W-430 engine of  
300 hp, underslung for pro-  
duction model, which will have

high speed of 150 mph., cruising  
speed of 100 mph., fuel capacity  
of 75 gal. giving range of 420  
mi. Gross wt., 2,000 lb., wa-  
weight, 1,025 lb.



**Short Helicat**  
Under design at Short Dev-  
elopment, Valley Aircraft  
Corp. According to designer,  
craft will be powered by 125-  
hp. engine, with room for two  
in first passenger, with room

for 125-hp. engine, at  
1,750 lb. main rotor diam. 30  
ft., gross weight 2,000 lb.,  
fuel capacity 75 gal. giving  
range of 420 mi. Gross wt.,  
2,000 lb., wa-weight, 1,025 lb.



**WCCopter**  
West Coast development new  
under construction under com-  
pany design. Franklin  
engine, 125-hp. Franklin  
craft is designed to have 40-  
mph. high speed; 80 mph.

resolving 3,000-ft. ceiling  
range of 40 mi. in 10-15  
mi. range. Gross weight, 2,000  
lb., fuel capacity 75 gal. giving  
range of 420 mi. Gross wt.,  
2,000 lb., wa-weight, 1,025 lb.



**Harwig-Little 'Copter'**  
Developed by Harwig Air-  
craft, prototype reported to  
have lifted 1,700 lb. three ft.  
above ground during test.  
Gross weight, 2,000 lb., wa-  
weight, 1,025 lb.

125-hp. Franklin, designed for  
high speed of 120 mph., cruise  
speed of 100; climb of 800  
ft./min., service ceiling of  
10,000 ft. Gross weight, 2,000  
lb., wa-weight, 1,025 lb.



**Miller Industries Miller-copter**  
Single - place experimental  
model designed as prototype  
to proposed production model  
which is expected to have 40-  
mi. range. Gross weight 1,000  
lb., wa-weight, 1,025 lb.

high speed of 80; climb of 800  
ft./min., service ceiling of 10,000  
ft. Gross weight, 2,000 lb., wa-  
weight, 1,025 lb.

## AMERICAN HELICOPTERS



**Leadgraf H-2**  
Single-place craft, it is first  
retractable landing gear heli-  
copter. Rotor blades of wood, ply-  
wood-covered. Fuselage and  
monocoque construction. Co-  
axial three blade rotor has

span of 16 ft. 5-in., rotor and  
main at 450 rpm. Gross wt.,  
450 lb., wa-weight, 120 lb.  
Powered by 10-hp. engine.  
(AIAA and Aviation, Oct. 1944,  
p. 100 and this issue, page 105.)



**Gyrocopter**  
American Aircraft Syndicate Ltd., Gyrocopter  
under development, said to  
be first of its kind. Gross  
weight, 1,000 lb., wa-weight,  
100 lb. Powered by 10-hp. engine,  
climb of 120 mph., cruise  
speed of 80 mph. Rotor and  
main at 450 rpm. Rotor and  
main at 450 rpm.



**P-T Engineering Paron P-2**  
High-speed laboratory model  
built as prototype of larger  
model now under design with  
25-hp. engine, climb of 400  
ft./min., cruise speed of 100  
mph. Paron P-2 has high  
speed of 10-120 mph., cruise

speed of 80; climb of 1,100  
ft./min., service ceiling of 30,000  
ft. Three-blade main rotor has  
25 ft. diam., rotates at 400  
rpm., and rotor has 5-  
ft. diam., rotates at 1,000 rpm.



**Twin Coax Co. Heaver-Twin**  
Two-place, coaxial rotor, co-  
axial rotor having rotor diam.  
of 30 ft. Powered by two 125-hp. Continental engines.  
Gross weight, 2,000 lb., wa-  
weight, 1,025 lb. Cruise  
speed of 75 mph., climb of  
800 ft./min. Rotor blades made of  
plywood, fabric-covered. Fuselage  
fabric-covered.



**Platt-Le Page S-1A**  
Two-place tandem seating 450-  
hp. craft recently delivered to  
AAF for testing. Contra-rotat-  
ing rotors mounted on tandem  
booms each have 20-ft. diam.  
Company has also done some

design work on 12-14 passenger  
coaxial rotor craft of 10,000-  
lb. gross weight, designed for  
military transport work, with  
operating costs said to be com-  
parable to conventional planes.

**Sikorsky HO4**

First helicopter to go into quantity production and first to be accepted for military service. Two-place craft powered by 250-hp. Warner engines. Used

as 3-blade main rotor, 26 ft. diam., of 3-blade anti-torque rotor, 7 ft. 8 in. diam. wt. 2,500 lb. max. speed, 125 m.p.h. Used by Coast Guard for rescue work.

**Sikorsky HO4**

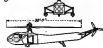
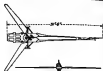
Two-place tandem seats. Streamlined tail boom replaces fuselage structure of HO4. Largest and most powerful of Sikorsky type built. Powered

by 450-hp. Pratt & Whitney Wasp Jr. 6-cyl. 18-in. diameter of 46 ft. diam. length of 47 ft. 10 in. gross wt. of 4,800 lb. max. speed, 125 m.p.h.

**Sikorsky HO4**

Two-place tandem dual control seats. Built by Sikorsky. Variable water intake. Powered by 340-hp. Franklin 6-cyl. max. speed of 100 m.p.h., cruising

speed of about 5 m.p.h., and maximum of better than 500 ft. min. 3-blade rotor diameter is 26 ft. 2-blade anti-torque rotor diameter is just over 7 ft.

**Armstrong Whitworth Albatross II**

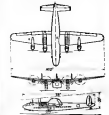
Originally designed as mailman's carrier, now serving as glider tug and freight transport. First built to go into service with retractable tricycle landing gear.

High speed, 250 m.p.h. gross; 300-mph. max. range, 1,500 mi. maximum payload, 5,000 lb. Powered by two 1,500-hp. Bristol Hercules. Gross wt., 28,500 lb.

**Avro Lancaster III**

Principal difference from Mark II, which is powered by four 1,600-hp. Bristol Hercules, is installation of four 1,200-hp. Rolls-Royce Merlin XXVII's. Pro-

duced in Canada and Australia as well as England. High speed, approximately 300 m.p.h., maximum range, 5,000 mi. gross wt. ranges up to 65,000 lb.

**Avro York I**

Built around Lancaster I wings, power plant and landing gear. Total length is 61 ft. 2 in. longer than bomber's and triple vertical fins have been installed for added

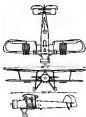
stability. Carries total of 34 passengers and crew of four. High speed is around 300 m.p.h. maximum fuel capacity, 2,450 gal. giving range of about 5,000 mi.



**Blackburn Blackhawk**

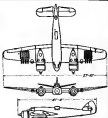
The old Palmer biplane being built in Blackburn has been extensively used for wide variety of missions including coastal and anti-submarine patrol. It was

recent work and modernization. Now armed with rockets, high speed, 140 mph, cruising speed, 120. Power one 775 hp Bristol. Gross wt., 7,720 lb., empty, 4,240.

**Bristol Scoutfighter III**

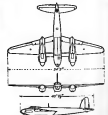
Two-place fighter-bomber, but now used extensively as aerial patrol and as weapons platform. Now shipping armament including rockets in addition to 20-mm.

cannon in nose and six 200-rod machine guns in wings. High speed, 300 mph, maximum range, 1,500 mi. Power, two Bristol Hercules of 1,000 hp, at one level.

**de Havilland Mosquito IV**

One of Britain's most versatile planes, has served as fighter, bomber and photo-reconnaissance craft. Some have been equipped with 75-mm cannon. Following

American B-25 developments, some, named, carry a 4,000 lb. bomb. High speed, over 400 mph. Two Rolls-Royce Merit 55.1 engines of 1,500 hp.

**Fairey Barracuda**

Designed for carrier operation, carrying one torpedo externally, or bombs or mine which the wings. Carries some of them. Torpedo-type dive flaps are set

below trailing edge. Wings fold back against fuselage when at sea. Added over. No performance data has been made available.

**Fairey Firefly**

Carrier-borne reconnaissance-fighter armed with four 30-mm cannon in the wings. Wings are folded manually for carrier storage. Flaps are same type utilized

on Barracuda. First mission was against Nazi battleship Tirpitz later sunk by heavy bombers. Power, Rolls-Royce Griffon II engines of about 2,000 hp.

**Gloster Jet Fighter**

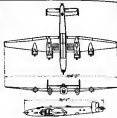
Built around single Whittle jet turbine unit set in fuselage engine after fashion of old Italian Caproni-Campini, with pilot's cockpit set above propulsive unit.

One of Britain's best jet fighters. It has been reported to action against Nazi bomb-bombers. No performance or design data have been released to date.

**Handley Page Halifax III**

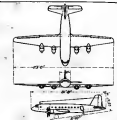
Whisper is greater than Mark I and II, which had 60 ft. 10 in. and 1,650-hp. Bristol Blenheim XVI engines replace Radio-Boyer Merlin XX's. Enlarged vent

ral fin for greater stability, installed on Mark II series, is continued. High speed is about 300 mph, maximum range about 300 mi., gross wt., 60,000 lb. plus.

**Handley Page Hermes**

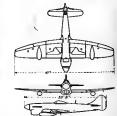
Prototype under development in bid for postwar transport market. One version to seat 54 day passengers; a deluxe version 200 seats. 50 for short hauls, 50

others, 32 by day and 16 by night by night. High speed suggested at 340 mph, maximum range 3,000 mi. Power, four 1,600-hp. Bristol Blenheims.

**Hawker Tempest V**

Developed from Typhoon, used largely as night fighter and against ground targets. Armament, four 20-mm. Hispano-Bolton cannons. Has laminar flow

wing section, and high speed is over 400 mph. at 5,000 ft. Powered by a 2,200-hp. Napier Sabre IIa 24-type 24-cylinder liquid cooled engine.

**Hawker Typhoon F.P.**

Like its successor Tempest, it is used largely for low-level and ground attack fighting, and is now armed with eight rockets, which may be fired in pairs or in salvo.

In addition to four 20-mm. cannons. High speed, about 400 mph. Powered by 2,200-hp. 24-cylinder Napier Sabre IIa-type liquid cooled engine. Range about 300 mi.

**Miles "X" Transport**

Projected passenger cargo and passenger capacity of 100,000-lb. gross wt. designed to carry 100 passengers. 2,000-2,500 sq. ft. greater number of shorter loads.

Control portion of passenger cabin will be 16 ft. wide. To be powered by four Napier Sabre engines buried in wings, driving four propellers.

**Miles 'X'**

Ordinary shock (above) of forward Miles II ship-board model-type fighter. By plane, 1941 immediately ahead of mid. front, stabilizing and lateral stability is in-

quired and design permits modification of heavy forward fuselage. This design, suitable for installation of liquid-cooled engine turning conventional pusher propeller.



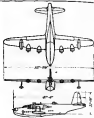
Above, is flying scale model—about half-size—of the Model 55 built for test purposes. Double model employed four-wheel fixed landing gear, but 35 would have retractable tri-

cycle gear. (For discussion of revised types by Gen. Miles, designer of these planes and a twin engine type, see "Shape of Things To Come," Aviation, September, 1944.)

**Short Sunderland III**

Reconnaissance-patrol bomber used for long missions. Some of type have been modified for transport work and others used to BSAC. High speed, 210 mph.

Maximum range, 3,800 mi.; fuel capacity, 1,500 gal.; service ceiling, 30,000 ft.; gross wt., 40,700 lb. Power four 1,010-hp Bristol Pegasus aircraft engines.

**Short Shirling II**

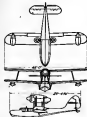
First of Britain's heavies, for a time used almost exclusively on mine-laying operations. Has also served as transport and glider tug. High speed, about 300 mph.

Service speed, 300 mph.; range, 2,000 mi.; gross wt., 70,000 lb.; wt. empty, 44,000 lb. Power four 1,600-hp Bristol Hercules XVI's. Crew of six or seven.

**Vickers Warwick**

Developed from Vickers Wellington bomber, this transport also has good offensive capabilities. Considerably larger than its predecessor it has wing area of 1,900 sq

ft., against 1700 for Wellington, and has gross wt. of 45,000 lb. Powered by either 1,800 or 2,000-hp. Pratt & Whitney R-2600's. Has range of about 2,500 mi.

**Vickers Sea Otter I**

Developed from Supermarine Walrus, is used as ship-based reconnaissance craft by Royal Navy and for ocean rescue by RAF. Hull is all-metal; wings

and tail surfaces have metal spars and wood ribs. Fabric-covered. Crew of three. Gross wt., 8,100 lb. Powered by one 870-hp. Bristol Mercury 35.

**Short Seafire III**

Carrier-based version of "Old England" Spitfire fighter modified for operating from carriers by folding down wings. Seafire was developed

from Spitfire Vc, but is heavier, its gross wt. standing at about 6,000 lb. against 5,500. Outer wing panels fold up and over fuselage while



wingtips fold down to horizontal position to make longer deck storage possible. Armament generally consists of four 20-mm. cannons, but

may be varied to consist of machine guns or combination of cannon and machine guns. Powered by 1,470-hp. Rolls Royce Merlin I.V.

**Vickers Supermarine Spitfire XIV**

Powered by 2,000-hp. pressure-rated Rolls-Royce Griffon with two-stage supercharger, has service ceiling of over 40,000 ft. Has five-bladed constant-speed Rotol

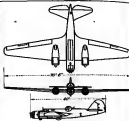
propeller. Armament varies between four 20-mm. cannons; two cannons and two 50-cal. machine guns or two cannons and four 30's. High speed, over 400 mph.



DB-3

Divenko-designed medium bomber powered by 1,000-hp. 31-875 radial engines, carrying crew of three or four. Armament consists of machine guns in bowleg and

and starboard, hand-operated machine gun in dorsal position. High speed, about 300 mph. at 10,000 ft., maximum range, 2,500 mi., gross wt., 30,000 lb.



DB-3P

Direct development of DB-3, powered by two 1,300-hp. 31-60 radial engines. Also carries crew of three or four and has power turret in dorsal position.

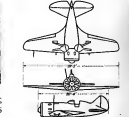
High speed about 370 mph. at 10,000 ft., cruising speed, 180 mph., range about 2,000 mi., service ceiling, 30,100 ft., gross wt., 22,000 lb. or more.



I-14

Developed from old Boring 3-20, this craft saw extensive service in Spanish Civil War and was kept in operation in current war. Two motor screws has been

used as advanced trainer. Armament reported to consist of two 30-mm. cannon and four 30-cal. machine guns. High speed, 300 mph., power, 1,100-hp. 31-60.



Leontkin

Leontkin-designed all-wood fighter powered by a 1,000-hp. M-100P 12-cylinder liquid-cooled V-type engine. High speed, 245 mph. at 10,500 ft., cruising speed,

about 200 mph., climb, 2,000 ft./min., landing speed, 57 mph., range, about 900 mi. Armament, 20-mm. cannon and two 12.7-mm. machine guns.



Le-4

Direct development of Leontkin, some later models have slightly raised cockpit for better view. Powered by twin-engine radial—it is one of Red Air

Force's few all-wood fighters—of better than 1,300-hp., high speed is around 300 mph., gross wt., 7,000 lb., wt. empty, 5,000 lb. Mixed wood-metal design.



Medved 3430

Believed to be a development of the 3410, this new Red Air Force fighter has a twin-row radial steam engine, probably turning up 1,000 hp. or more. Principal modification

appears to be in provisions for heavier armament—at least four guns in covering—and installation of new engine which should give high speed well above 300 mph.



Yak-4

Yakovlev-designed fighter, bomber, reconnaissance craft, powered by two 1,300-hp. M-102 liquid-cooled V-type engines. Carries crew of two. Armament consists of one

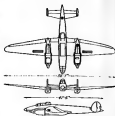
movable and two fixed machine guns, also reported used as dive bomber. High speed about 310 mph. Yak-4 is an advanced type of mixed wood-metal construction.



PE-3

Principal outward difference from PE-2 is installation of power control in place of hand-operated machine gun firing all just behind pilot. As in PE-2,

maneuvering is poorer in some low speed. It is possible PE-3 has slightly better power control giving somewhat better performance than earlier type.



MB-3

All-metal light-bomber widely used by Red Air Force with excellent results. Powered by AM-35, liquid cooled engine of 1,250 hp. at 10,000 ft. has high

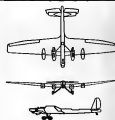
speed of about 360 mph. Gross wt. 6,200 lb. Armament varies widely. Bomber types are considered to have engines developing up to 1,000 hp.



TB-3

Tupolev-designed bomber now obsolete for combat, substituted in its stead exclusively for cargo transport. Powered by four 600-hp. Hispano-Suiza type M-64's.

top speed is only 125 mph., cruising speed, about 80 mph. Improving for its use of tandem wheels on fixed main landing gear.



MB-2

Three-to-five place single engine reconnaissance flying boat. Powered by 600-hp. M-37 BMW, craft has high speed of 160 mph., service ceiling of 11,000-odd ft.

range of 600 mi. Armament consists of machine guns set in bow cockpit and in dorsal turret set over aft of wing trailing edge. Used in Black and Baltic seas.



PS-84

None other than the Douglas designed DC-3, built in the Soviet under a license license agreement. Originally produced for service on Russian transport

lines. It has gone into military service. Powered by two 1,100-hp. W-60 engines which are probably Wright Cyclones also built under license.



PS-84

Widely used three-place reconnaissance bomber powered by two 1,100-hp. liquid cooled M-105 V-type engines giving high speed of about 210 mph. Of all-metal.

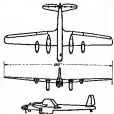
Push-rod control connections. Armament consists of two heavy caliber machine guns in nose, others firing aft from cockpit and from ventral position.



Yak-40

Eight-place heavy bomber, derivatives of YB-1. Powered by four 2,500-hp Hispano-Suiza type M-100 liquid-cooled engines giving high speed of about

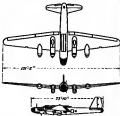
350 mph, and having service ceiling of approximately 26,000 ft. Has over-wing superchargers. Gross wt., 30,000 lb. Retractable landing gear.



Yak-7

Thirteen-place heavy bomber, powered by four 1,500-hp liquid-cooled A.M.-38 engines giving top speed of 280 mph at 25,000 ft., cruising speed of 210. Service

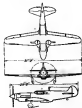
ceiling, 25,000 ft. Gross wt., 45,000 lb. Craft is reported to have been modified by installing more powerful radial aero-cooled engines.



Yak-1

Vakhrushev-designed all-metal fighter, powered by 1,500-hp, 12-cylinder liquid-cooled A.M.-38A engine with over-stage supercharger, giving high speed

of 300 mph. Some of the type have cannon firing through propeller hub plus machine guns. Others have eight machine guns mounted in wings.



Yak-9

Latest development of Yak fighter series, this model has cockpit canopy raised above fuselage for better visibility, and is reported a very maneuverable craft. Powered by 1,500-hp, 12-cylinder liquid-cooled V-type M-505p. It has

high speed of about 340 mph. Gross wt. is 4,800 lb.



IL-2 Sturmovik

Low-level attack bomber carrying crew of one or two, powered by one 1,200-hp liquid-cooled A.M.-38 giving top speed of 280 mph. A modified version,

IL-4, having different type canopy, has high speed of 350 mph. Bomb load ranges up to 1,000 lb. Extensively used as night bombing craft.



IL-76

Vakhrushev-designed craft developed from Maxim Gorky type 52 passenger transport work. Powered by six 1,500-hp liquid-cooled Hispano-Suiza type M-

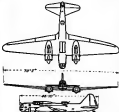
100's, has high speed of 180 mph, service range of 1,500 mi. Gross wt. is 300,000 lb. Originally designed to have capacity for 64 passengers.



58-3

A "workhouse" of Red Air Force, this medium bomber is improved version of 3B-2. Powered by two 500-hp. liquid-cooled Hispano-Suiza type 34

12's, it has high speed of 290 mph., cruising speed of 220 at 14,000 ft. Armament, boxes of machine guns in nose, others in dorsal and ventral turrets.



59-2

One of earliest Red Air Force planes powered by radial engine, it bears great resemblance to Brewster Nomad but is understood to be an independent de-

sign. Powered by 1,100-hp. M-40, has high speed of about 375 mph. Also reported modified as single seat, heavily-armed fighter plane.



P-2 (bomber)

Three-plane version of jet-propelled trainer designed and first built some 20 years ago. A modification has been widely used as ambulance craft.

5-17 (fighter)

Fighter-bomber powered by 1,100-hp. Hispano-Suiza type liquid-cooled M-230 engine, it has high speed of 315 mph., cruising speed of 275.



Jack 11 Navy Fighter

Short stubby Jack resembles Top, is used as interceptor. A twin-row engine of about 1,515 hp. gives Jack top speed of about 400 mph. with approximately

1,200-mile range. No armor or self-sealing tanks are reported. Armament is two 1.7-mm. and two 20-mm. guns. Riverer exhausts are fitted.



Nick 1 Army Fighter

Two-plane long range fighter-bomber, Nick has two Mikoyan-Goultsev radial of 1,100-hp. Heavily armed with 27-mm., 12.7-mm. and 7.7-mm. guns, top speed

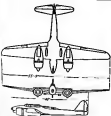
is close to 300 mph, and range about 1,000 miles. Of late Nick has also been used as a light bomber, and has been operational in raids on 20-25 Nagoya home.



Irving 11 Navy Fighter

Generally similar to Nick, this type is used for some defense-fighter and ground attack. Powered with two Mikoyan-Goultsev 21 radials of 1,000-hp.

Armament is unknown but believed very heavy including small high velocity 20-mm. cannon. Range is 1,200 mi. Improved Irving 21 has 230 mph. top speed.



**Tojo 2 Army Fighter**

Used mainly in CBI area. Tojo has Nakajima twin-eng 1,800-hp. model, over 250 mph. top speed. First Jap type to stay in a line with a P-40. Tojo is also very

maneuverable. But armor and self-sealing tanks have not been very effective and only four 10.7 and 7.7 mm. gun complete armament.

**Tojo 32 Navy Fighter**

Latest version of famous Tojo has monkey face. Nakajima Buho model of 1,000-hp. fitted with ejector type exhaust stacks. Top speed is over 350

mph. armament has been improved by substituting higher velocity guns. Buho is about 1,500 sq. ft. with auxiliary tankage. Smallest subsonic, smooth cowling.

**Tojo 3 Army Fighter**

First Jap-designed fighter with an inline engine. Tojo seems to be copy of Hurricane. (Kawasaki) 1,100-hp. engine can be fitted with both engines but some seem to have

been used thus far. Top speed is over 300 mph. engine with extra tanks about 1,000 sq. ft. armament varies—some Tojos carry four 12.7 mm. guns.

**Tojo 33 Navy Bomber-transport**

Designed as heavy bomber type. Tojo has become a Navy cargo-transport. Resembling a twin-engine B-24, wingspan is about 115 ft., length 80 ft. First large

Jap type to use triplex landing gear. Tojo appears to be well armed with machine guns and cannons. Construction of metal, engine make unknown.

**Tojo 32 Navy Fighter**

Formerly called Biang, this type is believed out of production but still over active. Nakajima Buho is a new model given top speed of around 350 mph, climb

of better than 3,500 fpm. Low velocity armament. Lack of armor or self-sealing tanks made Tojo a flying coffin for many 50p pilots. Gross wt., 5,570 lb.

**Tojo 31 Army Bomber**

New Jap medium bomber with a top speed over 250 mph, ceiling about 30,000 ft. Armament is 11-mm. guns in nose, tail, waist and belly positions and a 20-mm.

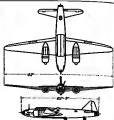
machine in top turret. Landing edge of wing covers engine forward as on B-24. Most of Tojo's model engines.



**Betty 22 Navy Bomber**

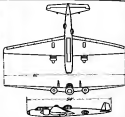
Famous Impeto-bomber has been cleaned up, given new engine, armament with power turret on top of fuselage. Powered with two Mitsubishi Kasei 1,

800-hp. radials, top speed is about 320 mph, range over 2,800 miles. Armament is two 24-mm. cannons. Drive 1.7 mm. rpm. Two torpedoes or equal bomb load.

**Nell 22 Navy Bomber**

Type has improved Nell with 1,600-hp. engines, better armament. Non-stop range is about 2,500 miles, weight empty 12,500 lb., climb about 1,100 ftm. Climb

load with striking H6M5 Prince of Wales and Kureha. Nell has crew of four to seven, at least four 1.7-mm. machine guns and a 20-mm. cannon.

**Sally 3 Army Bomber**

Still one of the Japs mainstays. Sally has bigger engine, hand-operated top- and tail-position torpedos. Still weak in armor and fuel tank protection. It is being

replaced by newer Hikos. Bomb load is 4,400 lb., crew of seven, armament is 1.7 mm. and 12.7-mm. machine guns. Top speed is around 375 mph.

**Shin 3 Army Reconnaissance**

Only type used by both Jap Army and Navy. Shin has high performance with 375 mph. top speed, climbs at 2,500 ftm., has range of 1,500 miles. Empty

weight about 8,000 lb., crew two. Weak feature is armament, only one 1.7 mm. gun in rear cockpit. Engines are Mitsubishi twin-row models of 1,000 hp.

**Lily 3 Army Bomber**

Operating mainly in CBI area where it is also used for reconnaissance. Like one-engine Martin B-26 type. Engines may be either Nakajima or Kawasaki radials;

crew is three or four. Increased bomb load up to 1,500 lb. No data available on its weight or performance. Reported to be under test by Kawasaki.

**Frances 11 Torpedo Bomber**

Frances reflects trend in new Jap aircraft which shows much originality. Known by Japs as Ghibli (Mitsui W32) it is latest high performance torpedo plane in

operation. "The Fish" are carried internally; armament is believed heavy. Construction may be all-wood smooth skin covering in contrast to usual metal.



Miyagi 11 Navy Reconnaissance

Fast and maneuverable, bearing a striking resemblance to U. S. Vulture V-110B, Miyagi has a twin 160-hp engine and four-bladed prop. Believed to be an

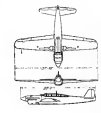
outboard type, with crew of 3-5, reconnaissance version is of very high order. The 2,000-lb. Mitsubishi engine is fitted with ejector exhausts.



Judy 11 Navy Dive-Bomber

Two place all metal monoplane powered by an Alfa Romeo engine of 1,150 hp. This type is generally regarded as the best. Top speed is about 325 mph, ceiling

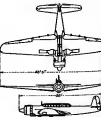
20,700 ft. As a bomber about 150 lb. of bombs are carried in fuselage and under the wings. Armament consists only of 7.7 mm. machine guns.



Kate 11 Torpedo-Bomber

At first believed to be an improved Kate 10, it is a new type, carries heavier load with all round better performance. Engine is Mitsubishi Kasei twin row radial.

Armament is very weak, only one 7.7 mm. gun in rear cockpit. 110 lb. bomb carrier and land-based, is believed to have four-bladed prop of late design and production.



Paul 11 Navy Bomber

New two-place high airplane taking India's place. Twin four stroke piston engines that it may also be in use as a torpedo bomber with torpedo carried ex-

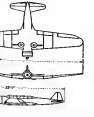
ternally. The twin row engine is believed to be 24 cylinder 500-hp. Mitsubishi Kasei with ejector exhaust stacks. Armament, believed to be 7.7 machine guns.



Senta Army Bomber

Development of Kariyusa civil type engine bomber for use mainly in CBI area. Outlined to serve Jap designs, Senta operates in quiet areas away from ap-

position. Engine is Nakajima of about 1000 hp. Four performance armament and lack of armor self sealing tanks make this craft very vulnerable to Allied planes.

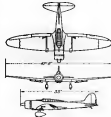


Kate Navy Torpedo-Bomber

New second line Kates are probably being replaced by 200. Evolved from Pauline 1101 engine in Nakajima Sakae of 1400-hp. Range 1000 mi., gross wt. about 7,200 lb., service ceiling 24,000 ft. Top speed is 290 mph. Armament is 17-mm. machine 2.5 cannon and fuel tank protection is weak.

Val 22 Navy Dive Bomber

Used by Zans in large numbers in early days of war Val is still in the field with modifications including more powerful engine and better diving Mitsubishi engine of 3472-hp gross early model top speed of 290 mph, range 875 mi. service ceiling of 25,000 ft. Crew consists of pilot and gunner.

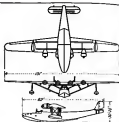




Navy 11 Navy Patrol Bomber

Direct copy of an early 50-knots design powered with two Mitsubishi Ki-200 or 1,000-hp. Main has range of about 4,000 miles. Also used as torpedo plane.

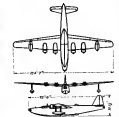
carrying two 500-lb. bombs. Weight is 25,000 lb. empty; top speed about 250 mph. With crew of 8-12. Armament is 7.7-mm. machine guns and 20-mm. cannon.



Navy 11 Navy Patrol Bomber

First Jap flying boat in full service. With 12 7.7-mm. and 20-mm. machine guns. Range 4,000 mi. top speed, 250 mph. Armament and self-sealing tanks have been

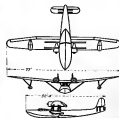
increased but Navy is still easy meat for enemy fighters. Engines are four Mitsubishi Ki-200 of about 1,000-hp. crew is usually of nine members.



Navy 11 Navy Patrol Bomber

Latest type Jap flying boat in full service. With 12 7.7-mm. and 20-mm. machine guns. Range 4,000 mi. top speed, 250 mph. Armament and self-sealing tanks have been

Mitsubishi radial fitted into wing's leading edge. Unbroken 800 m.p.h. speed. Sharp pointed clipper bow is feature of Jap flying boats.

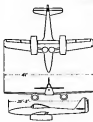


Heinkel He-100

Single-place jet-propelled interceptor powered by two BMW 600 gas turbines. Although no authoritative information is available on performance, it is not believed to be as fast as the He-202 which also has twin jet power plants.

Messerschmitt Me-262

Single-seat interceptor powered by two Junkers Jumo 204 gas turbines which give high speed of over 500 mph. Armament said to consist of four 30-mm. cannon, also reported to carry two 500-lb. bombs. First production to 200 P-50A. Armament.

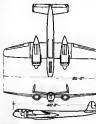
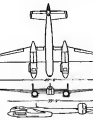


Messerschmitt Me-163

One of Nazi's fastest fighters, powered by rocket propulsion unit giving total of 20 min. powered flight. This is extended, however, by gliding all power and stalling. Reported to have attainable wheel landing gear for take-off. Reported maximum speed.

Arado Ar-240

Two-place fighter-bomber or reconnaissance craft powered by two 1,500-hp inverted-V liquid-cooled DB-602's giving top speed of between 325 and 350 mph. Cruise about 1,000. High bank load laterally. For high altitude pressure cabin is used.



Heinkel He-219

Night fighter or bomber equipped with two 1,700-hp inverted V DB-602's in radial overhang or two 1,600-hp BMW radial. Fighter has two 50-mm. machine guns and four 20-mm. machine guns forward and two 7.7-mm. twin-mounted rearward machine guns.

Focke-Wulf FW-190

FW-190 with 1,500-hp. Daimler-Benz DB-602 engine replacing the BMW radial engine gives high speed of about 400 mph, cruising at ground 300 without burning 50 mph. Landing speed.



**Focke-Wulf 190-A4**

Standard version of Focke-Wulf standard—modified in Arlington, Cal., 1944—powered by 1,600-hp BMW 801D attached engine giving best speed of 290 mph at 20,000 ft, with service ceiling of 26,000 ft. Other engines and machine guns removed.

**Messerschmitt Me-109B-14**

Latest in long line of Me-109 fighters. Equipped with Daimler-Benz DB-605 engine, delivering 1,500 hp at 20,000 ft, giving 1,500-1,600 hp at 16,000 ft. High speed 300 mph at 32,000 ft, cruising speed, 300 mph at 16,000 ft, service ceiling about 41,000 ft.

**Messerschmitt Me-410**

Modification of basic Me-210 fighter-bomber. Equipped with Daimler-Benz DB-605 engine, delivering 1,500 hp at 20,000 ft, giving 1,500-1,600 hp at 16,000 ft. High speed, 300 mph at 32,000 ft, cruising speed, 300 mph at 16,000 ft, service ceiling about 41,000 ft.

**Bombardier Do-337A**

Development of the Do-337C having added, isolated nose reported to mount up to 12 50-caliber machine guns. For night fighter work. Powered by 1,500-hp, BMW 801D engine giving high speed of over 325 mph. Do-337C is actually armed but has 1 40-mm 101-600 engine.

**Do-400**

Modification of basic Do-337C design adapted for night fighting and interception work by installing all-weather radar. Powered by two Junkers Jumo 211-Ps of 1,600 hp, giving high speed of 280 mph at 16,000 ft, service ceiling of 26,000 ft. Gross wt., 24,000 lb. Armament varies according to mission.

**Junkers Ju-388**

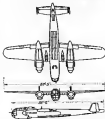
Appears to be enlarged version of Ju-388 with newer engine—BMW 801A or 801B of 1,600 hp—also having added machine guns giving greater nose-mounted engine and tail engine. High speed, 300 mph at 20,000 ft.

**Junkers Ju-352**

Enlarged version of old Ju-52 with either radial engine or 1,200-hp inverted V. Junkers Jumo 211A. Also added shoulder landing gear, retractable landing ramp under fuselage. Reported to be of mixed wood and metal construction.

**Bombardier Do-217M**

Development of the Do-217C powered by two 1,400-hp BMW 801D engines instead of 216CV engine. High speed about 295 mph, best load, 4,000 lb. gross wt., 22,500 lb. Armament consists of six machine guns.

**Focke-Wulf 300B**

Standard transport powered by four 1,200-hp BMW 801 radial. High speed, 295 mph at 16,000 ft, cruising speed, 304 mph. High speed, 300 mph at 16,000 ft, service ceiling, 26,000 ft. Fuel capacity, 2,112 gal. range, 2,200 mi.

**Meier & Voss BV-323**

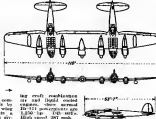
All metal flying boat used for long range reconnaissance or as troop transport with capacity of 100. Gross weight 19,000 lb. BV-323 has high speed of over 300 mph at around 20,000 ft, cruising speed of about 150 mph gross wt., over 100,000 lb.

**P.Z.S. 74 "Zerkow"**

First jet-engine craft to come into extensive use is possibly fabrication of new type of warfare. Possibility of engine of great capacity. (H) gives high speed of about 350 mph with 1,500-lb explosive load. (See Aviation, Nov., 1944, p. 160)

**Heinkel He-112**

Older jet made by combining two He-112Ps by adding a "Gustav" wing section which mounts a 1,500-hp BMW, thus giving



high craft, combining jet and liquid cooled engines, shows normal He-112 powerplants give 1,500 hp, 140-160 ft. High speed 287 mph.

## Aviation's American Engine Specifications

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Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

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GERMAN

**RUSSELL**

JAMES

6

<sup>1</sup> Delivered to be combination of all 4. <sup>2</sup> Designs 2, 4, 6 design, both active areas. <sup>3</sup> 2, 4, 6 design, both active areas.[illegible]



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 b. Below the title, there is a line of text that reads "JAPANESE AIRCRAFT" repeated twice.  
 c. The next line contains the text "JAPANESE AIRCRAFT" followed by "JAPANESE AIRCRAFT".  
 d. The final line of the header section is "JAPANESE AIRCRAFT".

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### Aircraft Specifications

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## AIRCRAFT

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## AIRCRAFT

DATE	DESCRIPTION	AMOUNT	BALANCE
10/1/88	OPENING BALANCE	100.00	100.00
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10/10/88	RENT	15.00	60.00
10/15/88	SALES	30.00	90.00
10/20/88	EXPENSES	10.00	80.00
10/25/88	SALES	20.00	100.00
10/30/88	CLOSING BALANCE	100.00	100.00

## AIRCRAFT

DATE	TIME	LOCATION	WIND	TEMP	REL	SEA	WAVE	WAVE DIR	WAVE PER	WAVE HGT	WAVE L	WAVE S	WAVE T	WAVE F	WAVE C	WAVE D	WAVE E	WAVE F	WAVE G	WAVE H	WAVE I	WAVE J	WAVE K	WAVE L	WAVE M	WAVE N	WAVE O	WAVE P	WAVE Q	WAVE R	WAVE S	WAVE T	WAVE U	WAVE V	WAVE W	WAVE X	WAVE Y	WAVE Z	WAVE AA	WAVE AB	WAVE AC	WAVE AD	WAVE AE	WAVE AF	WAVE AG	WAVE AH	WAVE AI	WAVE AJ	WAVE AK	WAVE AL	WAVE AM	WAVE AN	WAVE AO	WAVE AP	WAVE AQ	WAVE AR	WAVE AS	WAVE AT	WAVE AU	WAVE AV	WAVE AW	WAVE AX	WAVE AY	WAVE AZ	WAVE BA	WAVE BB	WAVE BC	WAVE BD	WAVE BE	WAVE BF	WAVE BG	WAVE BH	WAVE BI	WAVE BJ	WAVE BK	WAVE BL	WAVE BM	WAVE BN	WAVE BO	WAVE BP	WAVE BQ	WAVE BR	WAVE BS	WAVE BT	WAVE BU	WAVE BV	WAVE BW	WAVE BX	WAVE BY	WAVE BZ	WAVE CA	WAVE CB	WAVE CC	WAVE CD	WAVE CE	WAVE CF	WAVE CG	WAVE CH	WAVE CI	WAVE CJ	WAVE CK	WAVE CL	WAVE CM	WAVE CN	WAVE CO	WAVE CP	WAVE CQ	WAVE CR	WAVE CS	WAVE CT	WAVE CU	WAVE CV	WAVE CW	WAVE CX	WAVE CY	WAVE CZ	WAVE DA	WAVE DB	WAVE DC	WAVE DD	WAVE DE	WAVE DF	WAVE DG	WAVE DH	WAVE DI	WAVE DJ	WAVE DK	WAVE DL	WAVE DM	WAVE DN	WAVE DO	WAVE DP	WAVE DQ	WAVE DR	WAVE DS	WAVE DT	WAVE DU	WAVE DV	WAVE DW	WAVE DX	WAVE DY	WAVE DZ	WAVE EA	WAVE EB	WAVE EC	WAVE ED	WAVE EE	WAVE EF	WAVE EG	WAVE EH	WAVE EI	WAVE EJ	WAVE EK	WAVE EL	WAVE EM	WAVE EN	WAVE EO	WAVE EP	WAVE EQ	WAVE ER	WAVE ES	WAVE ET	WAVE EU	WAVE EV	WAVE EW	WAVE EX	WAVE EY	WAVE EZ	WAVE FA	WAVE FB	WAVE FC	WAVE FD	WAVE FE	WAVE FF	WAVE FG	WAVE FH	WAVE FI	WAVE FJ	WAVE FK	WAVE FL	WAVE FM	WAVE FN	WAVE FO	WAVE FP	WAVE FQ	WAVE FR	WAVE FS	WAVE FT	WAVE FU	WAVE FV	WAVE FW	WAVE FX	WAVE FY	WAVE FZ	WAVE GA	WAVE GB	WAVE GC	WAVE GD	WAVE GE	WAVE GF	WAVE GG	WAVE GH	WAVE GI	WAVE GJ	WAVE GK	WAVE GL	WAVE GM	WAVE GN	WAVE GO	WAVE GP	WAVE GQ	WAVE GR	WAVE GS	WAVE GT	WAVE GU	WAVE GV	WAVE GW	WAVE GX	WAVE GY	WAVE GZ	WAVE HA	WAVE HB	WAVE HC	WAVE HD	WAVE HE	WAVE HF	WAVE HG	WAVE HH	WAVE HI	WAVE HJ	WAVE HK	WAVE HL	WAVE HM	WAVE HN	WAVE HO	WAVE HP	WAVE HQ	WAVE HR	WAVE HS	WAVE HT	WAVE HU	WAVE HV	WAVE HW	WAVE HX	WAVE HY	WAVE HZ	WAVE IA	WAVE IB	WAVE IC	WAVE ID	WAVE IE	WAVE IF	WAVE IG	WAVE IH	WAVE II	WAVE IJ	WAVE IK	WAVE IL	WAVE IM	WAVE IN	WAVE IO	WAVE IP	WAVE IQ	WAVE IR	WAVE IS	WAVE IT	WAVE IU	WAVE IV	WAVE IW	WAVE IX	WAVE IY	WAVE IZ	WAVE JA	WAVE JB	WAVE JC	WAVE JD	WAVE JE	WAVE JF	WAVE JG	WAVE JH	WAVE JI	WAVE JJ	WAVE JK	WAVE JL	WAVE JM	WAVE JN	WAVE JO	WAVE JP	WAVE JQ	WAVE JR	WAVE JS	WAVE JT	WAVE JU	WAVE JV	WAVE JW	WAVE JX	WAVE JY	WAVE JZ	WAVE KA	WAVE KB	WAVE KC	WAVE KD	WAVE KE	WAVE KF	WAVE KG	WAVE KH	WAVE KI	WAVE KJ	WAVE KK	WAVE KL	WAVE KM	WAVE KN	WAVE KO	WAVE KP	WAVE KQ	WAVE KR	WAVE KS	WAVE KT	WAVE KU	WAVE KV	WAVE KW	WAVE KX	WAVE KY	WAVE KZ	WAVE LA	WAVE LB	WAVE LC	WAVE LD	WAVE LE	WAVE LF	WAVE LG	WAVE LH	WAVE LI	WAVE LJ	WAVE LK	WAVE LL	WAVE LM	WAVE LN	WAVE LO	WAVE LP	WAVE LQ	WAVE LR	WAVE LS	WAVE LT	WAVE LU	WAVE LV	WAVE LW	WAVE LX	WAVE LY	WAVE LZ	WAVE MA	WAVE MB	WAVE MC	WAVE MD	WAVE ME	WAVE MF	WAVE MG	WAVE MH	WAVE MI	WAVE MJ	WAVE MK	WAVE ML	WAVE MM	WAVE MN	WAVE MO	WAVE MP	WAVE MQ	WAVE MR	WAVE MS	WAVE MT	WAVE MU	WAVE MV	WAVE MW	WAVE MX	WAVE MY	WAVE MZ	WAVE NA	WAVE NB	WAVE NC	WAVE ND	WAVE NE	WAVE NF	WAVE NG	WAVE NH	WAVE NI	WAVE NJ	WAVE NK	WAVE NL	WAVE NM	WAVE NN	WAVE NO	WAVE NP	WAVE NQ	WAVE NR	WAVE NS	WAVE NT	WAVE NU	WAVE NV	WAVE NW	WAVE NX	WAVE NY	WAVE NZ	WAVE OA	WAVE OB	WAVE OC	WAVE OD	WAVE OE	WAVE OF	WAVE OG	WAVE OH	WAVE OI	WAVE OJ	WAVE OK	WAVE OL	WAVE OM	WAVE ON	WAVE OO	WAVE OP	WAVE OQ	WAVE OR	WAVE OS	WAVE OT	WAVE OU	WAVE OV	WAVE OW	WAVE OX	WAVE OY	WAVE OZ	WAVE PA	WAVE PB	WAVE PC	WAVE PD	WAVE PE	WAVE PF	WAVE PG	WAVE PH	WAVE PI	WAVE PJ	WAVE PK	WAVE PL	WAVE PM	WAVE PN	WAVE PO	WAVE PP	WAVE PQ	WAVE PR	WAVE PS	WAVE PT	WAVE PU	WAVE
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## AVIATION'S

### SKETCHBOOK OF DESIGN DETAIL



Exterior view of upper portion of Boeing B-29 Superfortress showing gun sight station and remote-controlled gun turret with two 30-mil. machine guns. This gunner can fire on only this turret, but can take over two others, guns of which will be aimed at same target.



limic soils of coastal Georgia Electric energy control system used in E.P.S. system, occupying soil A, rights through soil B and, when ready, passes trippers on girders C. Electric impulses are applied through cables D to soil shovels in center (but which can be located anywhere in plane) which compensates for speed, distance, gravity and parallel to operate through cables to target shovels at right.

**Franchises** **Franchise 500** 2012. **Entrepreneur** magazine's Franchise 500® is the most comprehensive source of information on the leading franchises in the U.S. Franchise 500® is a listing of the top 500 franchises in the U.S. based on a variety of factors, including sales volume, growth, and customer satisfaction. Franchise 500® is a valuable resource for entrepreneurs looking to start a business or expand an existing one. For more information on Franchise 500®, visit [entrepreneur.com/franchise500](http://entrepreneur.com/franchise500).





North American B-25 Mitchell in phantom view, showing installation of 14 50-cal machine guns and 13mm cannon to enhance its bomb load

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AVIATION'S SKETCHBOOK OF DESIGN DETAIL

AVIATION'S SKETCHBOOK OF DESIGN DETAIL

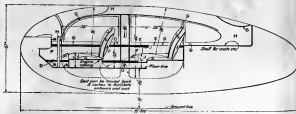
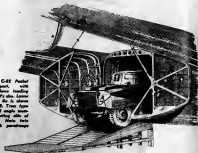


Front view of North American P-51 Mustang, showing installation and operation details. Craft is now officially credited with top speed of over 400 mph.

AVIATION'S SKETCHBOOK OF DESIGN DETAIL

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All end of Fairchild C-42 Foster superpressurized transport, with around air control down loading ramp giving idea of craft's size. Lower portion of right vertical fin is shown of its tube house of 6. True type fuselage C was of welded metal monocoque construction, supporting side of rear part of fuselage. Main tube doors D through which passengers ran out.



Cross-section view giving locations and dimensions of fuselage of Fairchild C-42 transport now under development.



All fuselage section of Landing helicopter, which attaches to pilot's seats at ballhead A. Main wheels of retractable tricycle landing gear are supported by left mainframe rear beam, one of which is at B. Landing gear strut C swings inward, held D permitting main beam to swing up and to. Fore and aft torque rods are shown at F and G respectively.

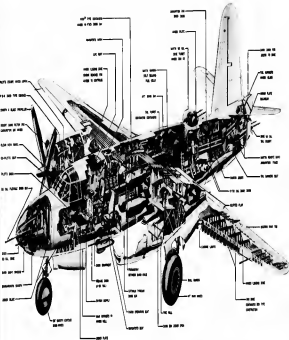


Exploded view of Douglas A-1 Skyraider displayed fighter showing major assembly components, including step two which gives initial member steps.

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AVIATION'S SKETCHBOOK OF DESIGN DETAIL

AVIATION'S SKETCHBOOK OF DESIGN DETAIL



Plan view showing construction and installation details of Douglas A-1 Skyraider.

AVIATION'S SKETCHBOOK OF DESIGN DETAIL

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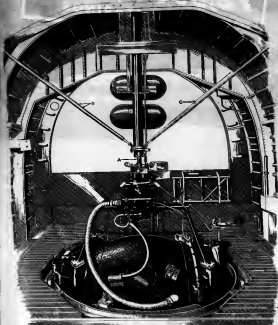


Ball-and-socket type wing spar connection for J3-B8 is shown in exploded form at A. Ball end of strut is at B and its relation to complete assembly is shown at F. Over this is fitted head ball of socket C, which is shown in complete assembly at C.

Next comes lock ring D—in complete assembly of D and head ball of socket E which, in turn, is at E in assembly. Head ring of E (F in assembly) is then attached finally and held in place by lock nut G, which is shown at G in complete assembly.



Tail wheel of J3-49 attaches to fuselage bulkhead at two points, one of which is shown at A. Retraction is accomplished through hydraulic piston C—which also takes part of load into clearance—by pulling up on yoke through point B. Wheel retracts on yoke through hole E. Its 10% shock loading shows, which would offset along line F, has been removed. It would be closed after retracting wheel through mechanism G.



Retractable ball turret installation in Consolidated Valco B-24 Liberator moves up or down on hydraulic piston A, held in position by hinges below B and C. In normal operation power is provided from plane's hydraulic system, but emergency hand pump D is also provided.

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## The Place of Industrial Research Prewar and Postwar

PART II OF A SERIES

By K. R. JACKMAN, Chief Test Engineer,  
Cassidated Feltus Aircraft Corp., San Diego

From the vantage point obtained by today's highly expedited wartime laboratory efforts, Author Jackman carefully examines the status and aims of research—to offer, in lucid perspective, a bridge between yesterday's limited progress and tomorrow's potential . . . Second is a group of articles gauging aircraft development, test, and research.

today, were the true figures to emerge from the cloud of military secrecy, there are probably considerably more, representing an annual expenditure of over \$250,000,000.

Research is, therefore, a sizeable industry in both the financial and personnel requirements fields, quite apart from its inherent possibilities of success or failure to industries with which it is

Working on preliminary sketches of an "off-line" pressure relief of pressure, General aviation engine Calvert gases to determine strength factors upon which load engineering will be based.

Map of the distribution of research laboratories of major nations, including as recorded in 1940, with each dot representing one laboratory. (From "Research—A National Economy," 1942, courtesy National Research Council.)



Research is an organized method for finding you reasonably dissatisfied with what you have —C. F. Ketter-

THE ARTIST HAS MADE, IN PART I of this series, the case for industrial research in the present aircraft laboratory tended to be research, development, and consulting to keep "the planes rolling" —rather than the academic take-month of the university or aviation laboratory to "solve cosmic problems".

Research laboratories in every industry are in a state of flux at the present time, leading again to an open-minded discussion of efforts to meet the changing demands of warfare and the problems for the postwar world. Science and engineering are moving rapidly to allow any laboratory to mobilize and stand still, even for a moment.

The old adage which states that "in the field of observation chance only comes to the road which is prepared" will be applied to the personnel and means of a modern industrial laboratory. For six months guided over the spectrum in tomorrow's highly-competitive world market may mean success or failure. In no other industry there are so many glaring examples of those who follow, are others, be it in the modern aircraft field.

The "desert" plane with the best performance or latest gadgets will win today's battle or tomorrow's postwar military order.

Even covering the specific problems of the aircraft laboratory, however, there are several general problems, common to most research laboratories, which bear consideration. The rapid growth of research and its distribution in the postwar years may indicate a trend which may be followed in post-war activity.

**Distribution of Applied Research**  
In 1938 the National Research Council recorded the existence of less than 500 industrial research laboratories maintained by commercial industrial concerns. In 1938 there were recorded 1,700, in 1940 there were 2,264; and

"... Landing gear equipment on Continental Planes is subjected to severe service and the various landing gear parts, such as bearings must be of the highest quality," writes Robert F. Six, president of Continental Air Lines, and adds: "Timken Taper Roller Bearings used in both landing gear and main wheels on our planes have been assigned 8,000 hours of service, which means 12,600 take-offs and landings."

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associated. Gaged in terms of employment in 1938, the "research industry" was equal in importance to that of dyeing and finishing of cotton fabrics which, in 1937, ranked among the 45 manufacturing industries which provided the largest number of jobs.

The development of industrial research has not proceeded uniformly in all industries; some established large research laboratories at an early date, whereas others considered research an unimportant activity and consequently their research efforts remained small. There are many factors which may influence the research requirements of a particular industry. The character of the processes involved, the age of the industry, the nature of the demand, the degree of competition, and the size and type of enterprise.

Research at this time is being presented to crystallize a few ideas on the probable scope, contribution, and the problems of the applied research, development, and routine test laboratories in the research industry in the early postwar years, it may be desirable to study a few statistics of a normal industrial year before this recent armistice year began, assuming that the present expanded laboratories will be somewhat reduced with the conclusion of the war. The year 1938 may be as typical as any, and for it we have a very complete laboratory survey made by the National Research Council.

Marion Holman<sup>1</sup> of this Council, presented in 1938 that approximately 500 universities were then engaged in pure-science experiments (basic research), whereas 30,000 men were working in applied science laboratories (on development and routine tests) throughout the country.

#### Many Had None

Perovich<sup>2</sup> in his splendid statistical study for the same Council, 1938 survey, states that of the 99,999 research scientists, technicians, and assistants employed by American industry in 1938, half were attached to 45 large companies. The other half were distributed among more than 1,700 firms, while more than 150,000 manufacturing concerns were without research laboratories.

The greatest amount of applied re-



This apparatus is used in early resistance of various metallic ducts to air water. In production shops, each of the pieces are automatically measured, then moved to down and stop. (Aluminum Co. of America photo)

search was being done, in 1938, in the relatively new mass-production industries, such as electrical goods, rubber, petroleum, industrial chemicals, and automobiles. These were also the industries in which, during the period 1928-1938, research activity grew most rapidly, as measured in terms of personnel employed.

For all the industries, the increase in the reported laboratory personnel between 1927 and 1938 was roughly 130 percent, or adding of 25,300 men and women in 11 yr. Approximately 10,000, or over 40 percent, of these added personnel were employed by the chemicals and petroleum industries. It was found in 1937 that there were approximately 303 research workers per 10,000 wage earners employed in the chemical industry. For radio apparatus and photomicrographs, petroleum, and rubber the corresponding figures were 252, 287, and 174.

It is difficult to make current comparisons of research strength with that of the industries noted—first, since the present technical manpower distribution is not generally skewed; and second, since the above definition of "research workers" may either include development engineering personnel or be limited to members of the development and research laboratories.

From the meager information that has come to the writer's attention, the probable applied research period (including development engineering) during the wartime boom of the last 10 years may not exceed 1 percent of employed wage earners, whereas in the industries listed above it is possible that the wartime average is close to 5 percent, or maybe more.

It is therefore again obvious that the research activity will have to be in research as a development problem, and the present laboratories at a really slow pace.

In 1938 the geographic distribution of research laboratories was skewed in the location of the specific industry. For instance, research in the chemical industry was concentrated in New Jersey, with Delaware and New York next in importance. These three states together employed more than half of those engaged in research in industry in the chemical and allied product industries.

About four-fifths of the research workers in the automobile industry were located in Michigan, the center of the industry, and practically all of those engaged in the development of agricultural implements were located in Illinois.

Laboratories engaged in rubber research were located in Ohio and New Jersey. Half of all research personnel in California were engaged, in 1938, in petroleum research, with the percentage still higher in large oil-producing states such as Texas and Oklahoma. The largest proportion of research on food products was done in Chicago, the center of the meat-packing industry, and all leading laboratories in the field of electrical communications were located in New York metropolitan area and in New Jersey.

#### Approach to Research

The technology of scientific actual research is too vast to be covered between the covers of any one book, and, accordingly, merely be available in such a series of articles as this. Those who wish working rules for the conduct of laboratory experiments might think whole libraries for reference details, but they may not actually

Fortunately, there are many authorities to advise the practical industrial researcher, so no fast of

on who blazed the trail are still alive, and time powers are willing to endorse the pitfalls and how to avoid them. M. J. Kane, in his splendid book *Practical Approach to Industrial Research*,<sup>3</sup> presents the accumulated experience of 57 yr. in American research, 1918 to 1957. Moreover, the directors of the great research laboratories point out, in their own words, the paths which they have discovered to lead to the probability of success in research, and so least expedient possible to avoid the blind-alley experiments.

Perovich<sup>2</sup> in his helpful book *Industrial Research*, states that most industrial laboratories have developed their equipment by trial and error, and so have inevitably like that housing pain—or better—caused by an accidental irritant. Growing as they have, without reference to the experience of others, none of the laboratories have been able to be profitable, in price, volume, or others have been called as "pains in the neck". There are more or less general rules of research management and organization and make the difference in drawing simple comparisons with the past or the best.

This series of articles—each on some parts of industrial research strategy work, incorporating much recent thought from others, and including specific illustrations—may be considered as an occasional guide for the young engineer and scientist, a manual for the research director and for the business executive, real or potential.

#### Fortunate Viewpoints

There is much wisdom in Baruch's oft-quoted admonition: "Consult your hands on a small scale (in the laboratory) and make your profits on a large scale (on the production line)." "In the laboratory," states E. V. Hedrick, director of research for the Bakelite Corp., "if we do not because, and volume to be, as much interested in the promotion of research in pure science as we are now interested in its application, we shall find it impossible to make life-long careers of new knowledge arising up at its source."

The industrialists must take a similar attitude that dividends may be obtained unethically. "Why not a 'nifty' sale," says Rodabaugh, "for the moment of new knowledge of value to his industry be not shared?" New knowledge becomes tomorrow's commodity of greatest worth.

"Men have regarded," comments Rodabaugh, "monopolistic control of new methods and of patent rights. If they do not also acquiring a commensurate rights of new knowledge through re-

search, they will lose their monopolistic hold."

Successful industrial research depends upon competent men working together rather than an individual genius. At rare intervals the scientific field is astonished at the discovery of a long-sought principle by an inexperienced worker. Kane, of M.I.T., cleverly shows the "savants' concentration in a recent cartoon (see below).

However, the legend should not build out hopes of being one of their "savants" great, for in today's organized research laboratories such "finds" occur only at rare intervals.

It was formerly possible for independent inventors to acquire the know-how and skills essential for the most revolutionary inventions. With the continued growth in the size and com-

plexity of industrial enterprises and in the volume of scientific knowledge, however, that became less and less feasible. Industry could no longer rely on random discoveries, and it became necessary to organize the systematic accumulation and flow of new knowledge.

This perspective for the rise of industrial research in its present proportions was being met by the formation of large corporations with ample funds available for investment in research.

In modern large industrial laboratories, whose work has become increasingly characteristic of today's research techniques, the research has itself become a mass production industry. Just as division of labor in manufacturing made possible significant increases in labor productivity, so the

## THE DEVELOPMENT OF AN IDEA WHAT EVERY RESEARCH MAN KNOWS



"First," said William Jones, "a new theory is offered or shown; then it is admitted to be true, but without investigation; then it is important; then the advantage is taken by the theorists; then it is discovered." (Cartoon, courtesy of Kane, M.I.T.)

<sup>1</sup>—M. J. Kane, *Practical Approach to Industrial Research*, 1957, p. 257. <sup>2</sup>—E. V. Hedrick, *Industrial Research*, 1957, p. 257. <sup>3</sup>—E. V. Hedrick, *Industrial Research*, 1957, p. 257.



## ***Simplified Numerical Integration For Design Engineers***

## PART II

By G. L. SHURE, Ph.D., Development Engineer,  
Consolidated Vultee Aircraft Corp.

Detailing how the difference-table method may be employed to solve higher-order equations in aircraft design, the author gives concise examples of application to heat transfer and compressibility problems . . . Conclusion of this two-part presentation.

To proceed to higher-order equations, the difference-table method may be expanded, although this naturally involves more work because several tables must be worked concurrently. The number of tables depends on the order of the differential equation. For example:

$$\frac{\partial z}{\partial x} = x + y + 1 \quad \begin{cases} x_0 = 0 \\ y_0 = 1 \\ \left. \frac{\partial z}{\partial x} \right|_{(0,1)} = 1 \end{cases}$$

The solution is

This is reduced to two separate equations by substitution.  
Thus:

$$\begin{cases} y = \frac{dy}{dx} \\ \frac{dy}{dx} = \frac{dy}{dx} = x + y + 1 \end{cases} \quad \begin{cases} x = \\ y = \\ z = \end{cases}$$

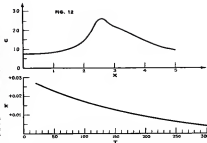
Two difference tables are worked successively. The general rule is that one table is worked until an entry requires a value from the other table. The second table is then worked similarly. Each table complements the other as the example proceeds. This is shown in Fig. 11.

In many instances the value of variables may be found on curves for which there is no equation. These values may be used directly in the equation for the iteration, and the numerical integration table is used in the usual manner.

Following is a typical aircraft engineering problem involving a heat transfer design situation:

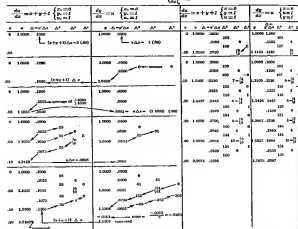
$$\frac{dT}{dt} = -0.004 U (T - 20) \quad \begin{matrix} T_0 = 300 \\ x_0 = 0 \end{matrix}$$

where  $k$  is a function of  $T$ , and  $U$  is a function of  $x$ . Curves for these functions are shown in Fig. 12, and the numerical integration thereof is shown in Fig. 13.



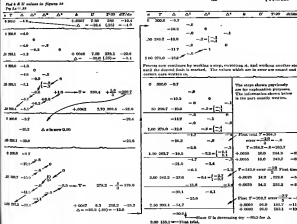
25. 11

Integration of  $\frac{dy}{dx} = x + y + 1$   $\begin{cases} x_1 = 0 \\ x_2 = 0 \\ x_3 = 1 \end{cases}$



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Fig. 4.  $\delta H$  values in the regions of the  $^{13}\text{C}$  NMR spectra.

$$\text{Integration of } \frac{dT}{dt} = 0.016 \text{ kU } (T-50) \left\{ \begin{array}{l} T_0 = 0 \\ T_1 = 100 \end{array} \right.$$


$$\frac{d^2 y}{dx^2} = \frac{M^2 \left( \frac{F}{M} - 1 \right)}{A F^2}$$

$$F^2 = 1 + \frac{2}{3} C_{F0} M^2$$

$$M = 2.5$$

$$B^2 = M^2 + \frac{2}{3} (1 - F^2)$$

$$n = 1.7 - 0.1 C_{F0}$$

$$A = \frac{\sqrt{1 - C_{F0}} - 1}{1 - C_{F0}}$$

$$C_{F0} = 0 \quad \text{Boundary} \\ C_{F0} = 0 \quad \text{Condition}$$

Starting table	$C_{F0}$	$C_{F0}$	$\Delta$	$\Delta^2$	$\Delta^3$	$\Delta^4$	$\frac{d^2 y}{dx^2}$
0	0	-0.00114	—	—	—	—	0.014
		-0.00094	—	76	76	0	
-0.1	-0.00024	-0.00046	76	76	76	0	0.006
		-0.00032	76	76	76	0	
-0.2	-0.00068	-0.00088	76	76	76	0	0.003
0	0	-0.01306	0	0	0	0	0.014
		-0.01306	0	0	0	0	
-0.1	-0.00024	-0.00046	0	0	0	0	0.006
		-0.00032	0	0	0	0	
-0.2	-0.00068	-0.00088	0	0	0	0	0.003
		-0.00094	0	0	0	0	
-0.3	-0.00114	-0.00134	0	0	0	0	0.001
		-0.00120	0	0	0	0	
-0.4	-0.00160	-0.00180	0	0	0	0	0.000
		-0.00166	0	0	0	0	
-0.5	-0.00206	-0.00226	0	0	0	0	0.000
		-0.00206	0	0	0	0	
-0.6	-0.00252	-0.00272	0	0	0	0	0.000
		-0.00252	0	0	0	0	
-0.7	-0.00298	-0.00318	0	0	0	0	0.000
		-0.00298	0	0	0	0	
-0.8	-0.00344	-0.00364	0	0	0	0	0.000
		-0.00344	0	0	0	0	
-0.9	-0.00390	-0.00410	0	0	0	0	0.000
		-0.00390	0	0	0	0	
-1.0	-0.00436	-0.00456	0	0	0	0	0.000
		-0.00436	0	0	0	0	

In a study of compressibility, it became necessary to integrate the following equation:

$$\frac{d^2 y}{dx^2} = \frac{M^2 \left( \frac{F}{M} - 1 \right)}{A F^2}, \text{ where}$$

$$A = \frac{\sqrt{1 - C_{F0}} - 1}{1 - C_{F0}}$$

$$B^2 = M^2 + \frac{2}{3} (1 - F^2)$$

$$F^2 = 1 + \frac{2}{3} C_{F0} M^2$$

$$n = 1.7 - 0.1 C_{F0}$$

$$\text{Initial conditions are:}$$

$$C_{F0} = 0, \quad \frac{dy}{dx} = 0, \quad \frac{d^2 y}{dx^2} = \sqrt{1 - C_{F0}}$$

This equation is fairly easy to integrate by the difference-table method. Consideration of starting the program is slightly irregular, because we change in the variables make appreciable changes in the derivative. We recommend the use of very small increments in making the table.  $C_{F0}$  changes as the dependent variable  $y$  or  $C_{F0}$  is then used as the independent variable. There are three factors in the equation which consist of the difference of two terms of nearly the same value:

$$\sqrt{1 - C_{F0}} - 1 = \frac{1}{2} \left( \frac{F}{M} - 1 \right) (1 - F^2)$$

when  $C_{F0} \gg 0$ . For this, at best seven figure computations are required. The integration is shown in Fig. 14.

The accuracy which can be obtained by numerical methods is dependent upon the size of  $\Delta x$ . Greater accuracy requires a smaller value of  $\Delta x$ , or makes more work in covering the same range in  $x$ . It is usually better to use  $\Delta x$  too small, rather than too large, starting the integration. The value of

$\Delta x$  is increased at any time after integration is started by merely using two desired  $x$  values and their corresponding  $y$  values, tabulating them as series in a new portion of the table. On the other hand, a reduction in  $\Delta x$  requires that an entirely new table be made.

In most equations, a very small change in a product or a large change in  $\Delta x$  is made  $dx/dx$ . In some cases the accuracy is improved if the variables are interchanged. In the author's experience, the results are interchanged when part of the needed integration is by adjacent tabulated values were close to the point where  $dx/dx = 1$ . After the switch, the value of  $y$  is not a simple decreased number, but also solved the problem. The process is similar to the one in Fig. 15. See reference books which denote a shift to numerical integration make it easier of illustrating the choice

or iteration method of successive approximations. In most cases, the solution is a matter of numerical integration accomplished by the analytical methods.

A splendid discussion of the value of numerical integration is given by James H. Scarborough in his *Numerical Mathematical Analysis*. It reads in part as follows:

"Suppose the equation  $dy/dx = (y-x)/(y+x)$  is given, with initial conditions  $x = 0, y = 1$ , and it is required to find several corresponding values of  $x$  and  $y$ . The given equation can be solved by putting  $y = vx$ . The results are:

$$y(x^2 + y^2) + \tan^{-1} \left( \frac{y}{x} \right) = \frac{\pi}{4}$$

To find pairs of corresponding values of  $x$  and  $y$  from this equation we could substitute the desired values of  $x$  and then solve the resulting equation for  $y$ . But this resulting equation will always be a complicated transcendental

equation which can be solved only by trial—by Newton's method or otherwise. The labor of solving this equation for even a single value of  $y$  would probably be as great as that of computing several tabular values by numerical integration."

Finally, our Fig. 16 shows integration of the above equation. The small value for  $\Delta x$  makes it possible to compare  $y'$  with a slide rule. The tabulated values are quickly calculated. As a check on the accuracy, take the values when  $x = 1, y = 1.4977$ , and substitute in the equation:

$$y(x^2 + y^2) + 2 \tan^{-1} \frac{y}{x} = \pi$$

$$= 2.343 + 2 \tan^{-1} 1.4977 = 1.877 + 1.064 = 2.941$$

$$\text{When } x = 2, y = 1.2697, \text{ we find the following:}$$

$$y(x^2 + y^2) + 2 \tan^{-1} \frac{y}{x}$$

$$= 2 \times 0.2117 + 2 \tan^{-1} 0.6348 = 3.1415$$

FIG. 15

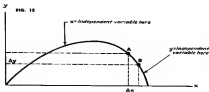


FIG. 16

Integration of $\frac{dy}{dx} = \frac{y-x}{y+x}$ with $x=0, y=1$									
$x$	$y$	$\Delta$	$\Delta^2$	$\Delta^3$	$\Delta^4$	$\Delta^5$	$\Delta^6$	$\Delta^7$	$\Delta^8$
0	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.2	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.3	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.4	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.5	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.6	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.7	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.8	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.9	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1.0	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

# EVALUATING THE VAUNTED V-2

By WILLY LEY, Formerly Vice-President, German Rocket Society

Here's a revealing analysis of this rocket-weapon's intriguing technical aspects, its war-worth, and its importance as a fresh-look factor in aerial research.

SINCE EXTREME SPECULATION was aroused concerning an RAF Bomber Command operational flight during the night of Aug. 17-18, 1945, that Prime Minister Churchill reported on the nature of the air attack in the House of Commons.

It had been an unusually heavy blow, yet had been directed against an obscure fishing village—Pescadoreau on the Rialto, situated at the extreme northwest tip of the Island of Urdow, the westernity of two islands sheltering the Bay of Stettin.

Churchill then disclosed that the Nazis had built a large research laboratory near Pescadoreau, which had been "the main experiment station both of the flying bomb and the long-range rocket." The report had it that the laboratory was virtually destroyed in the attack, with 5,000 of its 7,000 scientists and technicians killed.

The flying bomb mentioned by Churchill is the now well-known V-1, essentially a jet-propelled rocket-directed flying torpedo, carrying a war-

head of 1,000 kg., that is, 2,200 lb. Churchill's mention of the long-range rocket was the first official confirmation that there was a kernel of truth in the innumerable rumors then extant.

But the long-range rocket, now known as V-2, failed to materialize for a considerable length of time. In spite of all rumors and so-called eye-witness reports, in spite even of Churchill's reference to such a weapon, it seemed to many observers as if V-2 were merely a Nazi propaganda claim, or, at least, an experiment that had miscarried.

But after some of the V-1 bases were captured by the Allied armies, among the stores on England from these 150-mi.-range weapons, the long-range rocket did materialize. On Nov. 10, 1945, Churchill in a shorter report to the House of Commons, stated that V-2 rockets had been falling on England for "several weeks", landing "at widely scattered points."

In discussing V-2 it is necessary to consider its various aspects separately,

since proper evaluation of the merits of this invention is otherwise possible. V-2 can be considered as a weapon creating terror, and as a propaganda and psychological weapon. On the other hand, it can be considered simply as a rocket.

Considered as a weapon, V-2 is positively ineffectual and thus, in many respects, a long-range rocket bombardment would be an ineffective means of attack, even if guarded only as a substitute for a bombardment.

Considered as a terror or propaganda weapon its chief value is that it can be used without warning. Another type of terror value is, preferably, the V-2 is not accurate. Under conventional bombardment, populations living in distances from railroad paths, bridge piers, airports, factories, etc., power plants know they are relatively safe. Long-range rockets, however, may terrorize large sections of a population because they are just as likely to crash on a stretch of land devoid of any military targets as to hit or near a vital objective.

But because populations of war-torn countries have become somewhat hardened to air attack—whether by land-flying bombs, or rocket—the true value of the V-2 type of weapon is hard to estimate. Since actual drops and loss of the rocketing from its range bombardment is small for psychological attitude of the population, it is conjectural.

The reasonable conclusion, at present, is that V-2 still has to prove that its value as a terror or propaganda device is worth the expense. Considered, however, in the light of rocket research and engineering in general, V-2 must be admitted a masterpiece. Enemy development as a P-2 represents one of the greatest technical advances made during the last few decades.

It is advisable to select this weapon good, especially since on this side of the water we have, in the past, generally deployed remarkable resources in neglecting the value of even the existence of rocket motors. V-2 is a development which opens limitless possibilities, especially as its performance is in accordance with agreement with rocket theory as it was developed before liquid-fuel motors even existed. V-2 can, therefore, be regarded as large-scale experimental proof for the general validity of rocket theory and also as encouragement for other productions of rocket theory.

TABLE I—Theoretical and Expected Values of Exhaust Velocity ( $c$ ) for Various Fuels

Fuel	$c$ —theoretical (ft./sec.)	$c$ —expected (ft./sec.)
Black powder	5,000	4,000-4,500
Alcohol—oxygen	5,200	4,500-5,000
Alcohol—nitric acid	4,200	3,500-4,000
Gasoline—oxygen	5,200	4,500-5,000
Gasoline—nitric acid	4,200	3,500-4,000
Hydrazine—oxygen	5,200	4,500-5,000
Hydrazine—nitric acid	4,200	3,500-4,000

Note:  $c$  is approximately with liquid oxygen. Liquid fuels have been assumed to be 100% efficient. Theoretical  $c$  is based on the assumption of an infinitely small grain and a perfect nozzle.

ness is termed  $M_0$ . In this,  $M_0$  equals  $M_0 + M_0$  "payload" and the empty rocket, respectively. The mass-ratio is  $M_0/M_0$ , and for all fireworks and projectile rockets the numerical value of this expression is only slightly greater than 1.

The thrust  $P$  of a rocket has to be greater than  $M_0$ , since the rocket otherwise could not rise if the thrust developed by the rocket motor were less than the weight of the rocket.  $P$  is determined by the value for  $c$  in a given case and by the amount of gas contained during a given interval of time. The formula, then, reads:

$$P = c \times \frac{dm}{dt}$$

Since the molecules of the exhaust gas are considered infinitesimal as compared to the mass of the rocket, it is permissible to use the expression—

$$v = c \times \log_{10} M_0/M_0$$

for the relationship between  $v$  and  $c$ . Consequently  $v = c$  when  $M_0/M_0 = e$ , so that it is possible to arrive at a general formula for the relationship of  $v$ ,  $c$ , and  $M_0/M_0$  by writing—

$$M_0/M_0 = e^{v/c}$$

It is this formula which permits determining the mass-ratio requirements for a desired performance, and it is of great interest to acquire actual artillery performance with liquid-fuel rocket performance derived from this formula.

Three cases, which may serve as examples of such comparisons are given in Table II.

If the same weight of shell were to be transported over the same range by means of rockets, we would find the required mass-ratio given in the following paragraphs. (It was assumed

for these calculations that the rocket is a powder rocket with a propellant charge delivering  $c = 500$  m./sec. For simplicity, the muzzle velocity of the gun and the greatest velocity of the rocket at the instant when all fuel has been consumed were considered equivalent. Actually, a rocket would have traveled some distance when that velocity is attained.)

Case I would require a mass-ratio of approximately 1.15.  $M_0$  would be  $M_0$  (118 kg.) +  $M_0$  (12 kg.), or  $M_0$  would be  $M_0 \times 1.15$ , or 149.5 kg.

Case II would require a mass-ratio of  $e^{v/c}$ , or 1.34.  $M_0$  would be somewhat greater because of this higher mass-ratio, so that  $M_0$  would be, say, 135 instead of 130 kg.  $M_0$  would then be 169 kg.

Case III would require a mass-ratio of  $e^{v/c}$ , which amounts to approximately 5.76. For such high muzzle velocity,  $M_0$  would at least have to be equal to  $M_0$ , so that the lowest possible value for  $M_0$  would be 236 kg.  $M_0$  would assume a value of 1,366 kg., meaning that a rocket would require a powder charge of 1,134 kg. for the same weight of shell, and the same range which the gun could handle with an expenditure of 300 kg. of powder.

Despite this difference, a rocket might be preferable from point of view of financial expenditures. Guns are expensive, rockets comparatively inexpensive, and powder is cheap. The rocket would involve more weight of materials, but less in cash.

But because of engineering considerations, it is difficult to decide whether a mass-ratio higher than 1.5/1 would ever be employed with powder used as fuel. When liquid fuels are alone used as fuel, a different picture is presented. Liquid fuels not only require higher values for  $c$  (roughly twice as much), but also permit much higher mass-ratios.

In experimental liquid-fuel rockets of relatively small size, it is customary to force the liquid from the fuel tanks into the combustion chamber simply by the use of compressed nitrogen. This permits mass-ratios of 2/1 and 2.5/1, but hardly beyond that, since the fuel tanks are necessarily heavy in order to withstand the lateral pressure used to force the liquids into the rocket cones.

If higher mass-ratios are desired, it is necessary to provide a pumping mechanism which can force the fuel into the combustion chamber from low pressure tanks which are just strong enough to hold the fuel, and, consequently, rather light. The problem is, of course, to build the pump and pump drive sufficiently light so that introduction of the unit results in a saving in weight.

It is likely that, to do the job, much

Some of mechanical workings of Nazi high-flying superpowered V-2 rocket bomb are revealed in the shot of wreckage found in Belgium. Near it found of combustion chamber and rocket are parts of turbine and pump assembly. (Associated Press photo.)







# What Makes Expert Mechanics EXPERT?

PART I OF A SERIES

By E. F. LINDSLEY

Emphasizing that yesterday's "nose 'em by ear" boys are now "set," the author carefully charts today's engine maintenance field to show what modern requirements demand of a man . . . First of a group of lucid articles detailing the various working phases of engine service and overhaul.

OF THE THREE aircraft engine maintenance divisions—line maintenance, trouble shooting, and overhaul—the first two probably are not as clearly divided as our accompanying chart would indicate. For line maintenance and trouble shooting frequently overlap. Line maintenance is shown in the chart as comprising routine line checks, replenishment of fuel and lubricants, and replacement of the more rapidly wearing parts, such as sparkplugs. Also included are accessory adjustments, particularly on new, or recently overhauled, engines.

Second maintenance category, usually termed "trouble shooting," includes corrective measures after trouble is located and requires well integrated knowledge of the engine, plus much patience.

A decade or more ago the so-called "top overhaul" was accepted practice in nearly all power ranges, since it was believed that the actual power produc-

ing units—cylinders, valves, rings, etc.—were prone to wear more quickly than the power transmitting system, or crankshaft and gearing. Machinizing and design progress has, however, eliminated to a large extent the need for top overhaul. The result is that the modern engine mechanic is called upon to do only occasional work on a cylinder or valve mechanism damaged by improper operation or mechanical malfunctioning.

Of course these trouble sources will be with us so long as crankshaft and cylinders, their associated dies, and so on, are used either by designers or producers of our excellent present-day engines.

In the higher power ranges used in current aircraft, engine overhaul divisions merit clearly from the two foregoing types of maintenance. It has not been unusual in the light plane class for a mechanic to tear down an engine in the hangar, using only a small complement of hand tools, perform a rather generalized overhaul, and re-

build the engine so that it would spin successfully. But the mechanic knows that the crowd will be saying this sort of thing after the war (or later) will then be accomplished at licensed repair stations or large shops, with precision tooling then located on the larger engines.

Today's expert engine overhaul differs decidedly from the trained flyer-mechanic previously usually portrayed as diagnosing power plant malfunctions with the proverbial pencil. Now, your average engine mechanic is, and will be, represented by the grizzled, tool-maniac type mechanic with years of experience in power machine shop work and with a recognized to a micrometer scale. Modern mechanical work also gives rise to specialization, both from the mechanic's viewpoint of the repair and operator and from the technical standpoint of concentration of skill in a specialty work. A man need know no expert.

No mechanic can inspect any of the most parts of varied make or models of engines at irregular intervals and still be a truly competent spectator; positive inspection skills are required at inspecting other engine type parts in a large number of similar engines. Thus the engine mechanic is called upon to know what to look for, to look for it, and what must be done to rework used parts into such

condition that they may be re-used. He has now distinguished at least two phases of this work which may be termed equally important. Not mentioned yet are the more or less required maintenance in propeller, battery, and instrument overhaul. Only a man who professes to be fully competent "on the line," shooting and connecting troubles, overhauling engines, maintaining propellers, and servicing accessories, in being off a job would.

## Right-Line Maintenance

To put that effects the operation of an engine may be considered as trivial as it requires specific technical skill. Even the line mechanic can pick out the checks and signals to the pilot answers responsible both for his own work and that of his co-workers.

If the line mechanic is called upon to perform more than routine repairs of fuel and oil, his job log may call "Serviced airplane #2 with 50 lb. 100-ounce gas and 2 gal. #130 oil." Recently, he did exactly that—filled the ship with gas and oil.

With less service in mind, however, a competent line mechanic would probably accomplish several other things while in the simple process of replenishing.

Let us watch this experienced mechanic supplying a plane with oil and fuel.

As he walks to the plane he notes the make and model of the engine, usually thumbing through his life of instructions, remembers that this engine needs 100-ounce fuel, and then looks to be sure. This would require turning the plane down the line to the 100-ounce gas pit. Likewise this mechanic notes miscellaneous details, such as trim and adjustment of oiler valve, die position and condition, oil cooler and feedings. And now, given the time, he taps on the roof and down the fasteners to use if the oiler is properly secure. Such tapping (with a helpful check, provided the engine with enough strength to hold its own) adds on the cooling in the pit.

Properly developed the powers of observation to a remarkable degree, the mechanic who appears to give no more than a glance at an engine often has and moreover knows it, such as loose hose clamps, improperly connected terminals and failing fittings. This kind of mechanic is not recommended for minor maintenance, which should be performed with more care.

However, a more pleasing eye and oil dip is not as a routine inspection

Here, the secret lies in also observing each individual unit and group of items for a fraction of a second. Everyone has had the experience of staring at a printed page without focusing attention on the words. When remembered, that, the writing is meaningless, yet, when one gives concentrated attention to each word for a fraction of a second, starting becomes reading. So say an observant mechanic "reads" an engine.

Nearly covers the job of starting the engine and taking the plane to the 100-ounce pit. Here, the following considerations are paramount for disregard of these may cause engine failure and as likely to reduce engine life and reliability: (1) What type is the starting device—direct crank, electric, or other?



Engine start shows how complicated one and standard aircraft design requires

direct crank, standard inertia, carburetor, or other means? (2) When and how does the booster current cut in and out? Is it automatically engaged when the starter is switched, or must it be applied manually? (3) What type of priming system is used? It might be three points to the carburetor, primer and diffuser system, five points to the cylinder intakes, or merely the acceleration pump in a float carburetor. Is the primer operated by a solenoid, or is it manual? Mistaken here can cause extreme engine damage by allowing the lower cylinders to liquid lock, or mixture can bring about severe backfiring and fire hazards.

Some of the other points are: Proper position and operation of mixture control, throttle, fuel selector valve, primer, fuel pressure control, overcharger control, fuel pressure switches, and fire extinguisher releases.

Generally, these various questions may be answered by consulting manufacturers' instructions, but the human element or technique also enters the picture.

Some mechanics could wear out a starter on a cold day and still not start the engine, either might accomplish the start on the first move simply because

of that intangible quality called experience. Of course, to start engines successfully requires experience, and this experience must be intelligently employed regarding such points as the size of the primer, length of run-up on the battery starter, and the time for cutting in the magneto.

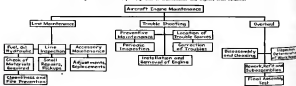
Before starting, the mechanic has fixed in his mind the locations of the primary engine gauges, namely: Oil pressure, tachometer, manifold pressure, engine temperature, oil temperature, and fuel pressure. Not only has he a clear picture of their location but he also knows what each reading should be during start and warm up. Any deviation from these preconceived pictures of what the engine should be, immediately brings the action necessary to correct the improper reading.

Setting of cooling controls, such as flap and oil cooler shutters, should be such a part of the starting and warm-up procedure as operating the throttle and mixture. Almost without exception the cooling flap should be open for ground running in spite of low head temperatures. When the engine has been brought to a point where the oil pressure does not fluctuate with variations in throttle position, the mechanic tenses to the 100-ounce fuel pit, shows the engine to cool, and then shuts it down so he can care for his original job of refueling. Before leaving the cockpit he makes a quick check for leaking primers and for exhaust flames from the burning manifold or heat exchanger. He also notes that oil, valves, and controls are in their proper position.

From the foregoing we may readily see that the competent line mechanic is aware that a handle of oil cans and gauges. Even the control required to enable the mechanic to perform a refueling again free from static, checking filler caps for type and quantity of fuel and oil, noting the condition of breather and vent, assuring absence of leaks, and the condition of liquids, and inspecting fuel strainers for water and foreign materials.

In observing this competent line mechanic at work, we may note that instead of supplying the oil from a readily available pump out of "X" brand, he walks some distance and returns with a supply of "Y" brand oil. This was because oil should be of the same brand or just as the same viscosity as that already in the engine, since various oils differ slightly in their chemical makeup after being refined. Although any oil of aviation grade is satisfactory when used alone, mixing different brands may spoil the good qualities of all by bringing about undesirable chemical reactions, causing

This diagram details three basic phases of maintenance and depicts their relative importance.



formation of sludge and engine varnish and resulting in clogged oil passages, poor lubrication, and consequent heat conduction due to sludge coating of engine parts.

One good mechanic's job is not completed until he is assured of the security of all filler caps, vent pipes, and gas struts, and has wiped up any spilled fuel or oil. Finally, he notes the accomplished work in the record and signs for it.

#### Changing Plugs

Replacement of sparkplugs is one of the more common jobs handled by the line mechanic. A small wrench is provided in most engine tool kits for loosening and retightening sparkplugs of this concern. With this tool, the wrench, that causes other pliers are used will be avoided.

It is to be noted that over-tightening with a standard wrench will damage both harmonic and vibration dampers on a sparkplug. A torque-indicating extension handle (or a short handle permitting reasonable torque judgment), and sparkplug thread lubricant are the main items needed for the plugs themselves. Plug caps and thread protectors are also handy; these will be discussed later.

It is good practice to loosen both ends of the sparkplug elbow before removing the sleeve and terminal from the plug. The extra flexibility back of the elbow is a valuable aid in removing the terminal without cramping the sleeve in the plug barrel and possibly damaging both terminal and sleeve. If terminal assembly is jerked out in a careless manner, or if the terminal spring is allowed to bear against the inside of the plug barrel, damage is likely to result and the gas-tight interior of the plug may be scratched or chipped, requiring the line mechanic to shorten the life of the plug.

Other common troubles arise from bending the "pigtail" (or terminal contact spring) out of alignment, or cracking the terminal sleeve for "finger-loose." Terminal assembly in the above ways are very likely to bring new plugs or flash over and cause as much trouble as did the original worn plugs.

When all the elbows and plugs have been loosened enough to turn easily with the fingers, each plug should be removed placed in a rack, and a new plug substituted for it in the engine. New plugs may be left finger tight and tried to apply the final torque to all plugs.

Overlopping procedure serves two purposes. First, it prevents the entrance of dirt and other foreign matter into the cylinders. Equally important, it

makes it easy to place the plugs in an orderly fashion in a rack. It takes a little more care to place plugs in a rack than to toss three loosely into a box, but a number of advantages are gained by the expenditure of the extra effort.

One advantage is purely mechanical. Racking of plugs prevents threaded portions from striking each other. Damaged plug threads stick in bronze cylinder bushings, and any mechanic who has experienced the dubious pleasure of removing a plug that has secured itself to the cylinder bushing will concede the point that the racking system is to provide plastic or brass thread protectors for each end of the plug.

Second advantage gained in successful replacement of sparkplugs is the fact that the trouble shooter may then examine the electrodes to detect just which cylinders are fouling worst. This advantage helps select the ignition troubles and is frequently of great value when investigating excessive oil consumption.

If each mechanic were to purchase, from his own pocket, a set of high grade aircraft sparkplugs, he would quickly gain a reputation of their confidence. Aviation plugs are expensive because they are properly made. They demand correspondingly precise service and installation.

Thread lubrication is a frequently overlooked point. The thread lubricants with stand the tremendous heat involved and should most certainly be used—but sparingly. A strip of lube should be laid up the side of the base thread with a small rack about the size of a match. Never "dash" the plug nor allow the lubricant to work down around the electrodes. No lubricant is necessary at the elbow connection, in fact it is highly undesirable. Sparkplugs should turn on easily with the fingers until they are almost ready to bottom against the socket. If a plug cannot be turned in without a wrench, suspicion should be made to check the cause of the binding. Damaged threads in the bushing or on the plug will usually be found.

When all plugs have been replaced "finger tight", the final reason should be applied with a torque-indicating extension handle on the proper size deep-wrench wrench. Torque values as high as 450-500 in.-lb. have been used and probably are conducive to excellent heat conduction; however, experience shows that 400 is ample and even lower values—around 350 in.-lb.—may, even causing some engine trouble. The troubles so commonly encountered in removing plugs. Excessive tightening may cause plug sticking, thread dam-

age, and sometimes electrode distortion.

If a torque wrench is not available, the mechanic must still apply the proper torque on each plug. One manufacturer recommends a wrench with 10-in. extension handle. This should be satisfactory if the mechanic would fail to apply the pressure slaps at some point on the wrench handle and he has a reasonable sense of touch.

Good practice calls for a gap once check (which may be obtained if the plugs have just been checked and adjusted). Gently insert any moisture or foreign material into the barrel of the plug with a clean, dried stick of the proper size, or the cleaner twice folded double. When using such plugs, caution should be exercised to turn the cleaner in the same direction as the plug is being turned to prevent picking up of debris. A clockwise direction is usually correct, although it's a good idea to be first.

Sparkplug terminal contact on sleeves must be clean and free of any indications of burning, erosion, chipping, or collapse. When good conditions are critical, finger pads may cause flash-over, so never use an ignition parts with greasy hands. Use carbon tetrachloride to remove grease or oil around the terminals.

Harsh elbows and sockets should be individually inspected in dirt, cracks in shielding and possible missing washers, missing ground wires and moisture seals, possible chipping, broken elbows, and loose threads.

The small "bar"-shaped dies at a wrench provided by the manufacturer is handy, and in addition provides a reasonable gauge of the proper torque. If such a wrench is not available, the mechanic should use careful judgment in tightening these nuts. Only one torque is to be used in every case; any further tightening may cause the plug core to rotate or may distort the electrode.

We have now observed, in some detail, two jobs commonly encountered by the line mechanic. The jobs, if properly done, have been considered, however, do serve to illustrate not only the mechanical techniques involved but also the proper attitude necessary.

The capable airplane engine mechanic, in addition to observation of details, follows systematic work sequence for a specific purpose for each engine he makes, continuously applies logic constantly while working, has a keen curiosity, and is ready to make the adjustment for service or trouble. There are his prime traits. Devotion to duty, or overconfidence or carelessness, will overcome or later bring about



## Warehouse on Wings

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fields of merchandising, to find more goods which can travel via air with better loads to mechanic and to air carrier. Still another job is to bring new down to additional pools can move economically via air. Both rates reduce from maximum efficiency of operation and also from full production. Wright Cyclone engines with a payload bonus day to their lower weight ratio, and with ease of maintenance and low fuel consumption to provide efficiency, are helping to make each carrier a reality. Wright Aircraft Engines Corporation, Dayton, Ohio, June 1, 1934.

### Cyclones Save 3 Ways

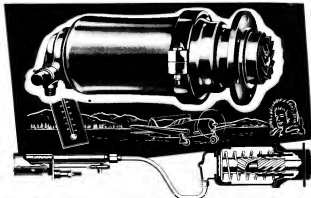
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The Breeze Cartridge-type Engine Starter, designed for quick, positive action even at the lowest temperatures, makes possible an unlimited number of starts without the handicap of a heavy battery. Operating on the familiar push-drive principle, the lightweight, yet tremendously strong mechanism of the Breeze Starter transforms a 30-500 thrust into 150 RPM at the crankshaft. The various models of the Breeze Cartridge Starter, in service today with many of America's fighting aircraft, will spin into life engines ranging from 300 to more than 2000 horsepower.



Manufactured under Goffman patents

**Breeze** **CORPORATIONS, INC.**  
Newark, New Jersey

## HIGH VS. LOW ALTITUDE TRANSPORT

PART II

By PHILIP COLMAN, Chief Aerodynamic Engineer, Lockheed Aircraft Corp.

Engine power requirements for high and low altitudes are here compared—to the manifest advantage of the high altitude design.

CALCULATING POWER required in altitude is one of the major design considerations for transport craft. This may be any amount of miles (maximum cruise speed) power up to 70 percent, and is dependent on other transport design considerations.

It is beneficial to design as small an engine as possible, because a larger engine requires a larger nacelle, causing higher drag and greater empty weight. High lift, particularly at short, must be chosen as a safety requirement because that is its basic reason.

Today, we have a guide to define flight safety in terms of airplane performance, as presented by the Civil Aeronautics Authority in CAR 94.75. Later CAR 94.753-E are specified certain rates of climb required for the airplane in landing, approach, and take-off while CAR 94.753-E defines take-

off runway length in terms of the distance to accelerate from standing start to critical ground speed, plus the distance to climb to 30 ft. altitude with one engine inoperative.

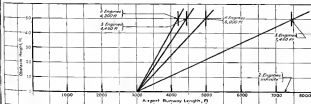
Because airports are of limited size, this latter requirement is the most critical relative to a large, long-range transport. Therefore this prerequisite may determine takeoff lift, or the takeoff powerloading for the airplane.

For an example, a four-engine airplane is assumed. This choice may be easily explained by the graph in Fig. 3. An airplane with a given total lift will take the same distance to accelerate to the critical speed with all engines

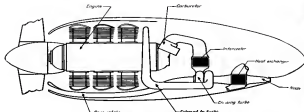
operating, regardless of the number of engines employed. This assumes that the same critical speed for each engine installation, also sufficient lateral control, is available. After critical speed is reached, climb must be made with one engine inoperative, and the more engines, the less critical will be the loss of one of them.

Fig. 3 is based on the four-engine airplane requiring a total distance of 5,800 ft. A three-engine airplane requires 2,430 ft. more; a five-engine airplane, 350 ft. less. While such a two-engine airplane does not get off the ground, a six-engine airplane reduces the distance another 500 ft. Thus, the

Fig. 3. Graph shows various runway lengths required for aircraft having constant lift, but equipped with different numbers of engines.



ATTENTION: This is a preliminary drawing and is not to be used for construction purposes.



more engines the better, from the takeoff viewpoint. But the more engines the greater the weight and drag, plus another very important aspect—the greater complexity of design and control which might detract from the actual safety of flight.

The decision here is that if a well balanced four-engine design can be made affording a takeoff of 5,000 ft., the gain over the three-engine airplane is 50 percent, and the loss compared to a six-engine airplane is 30 percent in airport runway length.

Returning to the derivation of required takeoff power loading based on C.A.B. 04752-T, the following equations apply:

$$\text{Ground run} = \frac{K (W/P_{T/O})}{P_{T/O}}$$

where:  $\frac{W}{P_{T/O}}$  = engine-to-takeoff weight  
 $P_{T/O}$  = critical takeoff power  
 $K$  = average excess thrust—thrust available minus friction minus drag

This may be rewritten in the form:

$$\text{Ground run} = \frac{K W}{(P_{T/O}) \left( \frac{1}{L/D} \right) \left( \frac{1}{C_L} \right) \left( \frac{P}{P_{T/O}} \right)}$$

where:  $C_L$  is constant take-off lift coefficient  
 $\rho$  is air density, a constant

$\frac{P}{P_{T/O}}$  is average thrust-power ratio, and  
 $P_{T/O}$  is takeoff power

The following equation is written to show that ground run is proportional to wing loading times the power loading:

$$\text{Ground run} = K_1 \left( \frac{W}{S} \right) \left( \frac{P}{P_{T/O}} \right)$$

The climb portion of the takeoff may be approximated from the formula:

$$\text{Climb distance} = 30 \left( \frac{W}{P_{T/O}} \right)$$

where  $P_{T/O}$  = excess thrust in climb.

the thrust less the drag. The drag cannot be neglected in this equation, because with one engine inoperative it approaches the value of the thrust. The equation may be rewritten:

$$\text{Climb distance} = \frac{W}{30 \left( \left( \frac{P_{T/O}}{P_{T/O}} \right) (P_{T/O} - \frac{W}{L/D}) - \frac{W}{L/D} \right)}$$

This equation is given to prove that the total distance is a complex function of wing loading and power loading. However, to demonstrate the point in need it is permissible to say that the total runway length required is a function of power loading times wing loading. Substituting back from calculations, an approximate formula for an airplane of the size and type considered here for a 5,000 ft. airport length is:

$$\left( \frac{W}{S} \right) \left( \frac{P}{P_{T/O}} \right) = 750$$

Consider now the power required for cruising flight. The equation for power loading based on cruising power is:

$$\left( \frac{W}{S} \right)_{\text{cruise}} = \frac{375 (L/D) (\rho) (a) (W)}{P_{T/O}}$$

where, following previous assumptions,  $L/D = 23$ ,  $a = 87$ ,  $P_{T/O} = 180$  mph indicated

$$\left( \frac{W}{S} \right)_{\text{cruise}} = 43.2 \times 10^6$$

With a cruising and a takeoff formula, a choice of desired power percentages will result in a choice of wing loading and power loading. The following percentages are derived from typical current engine data:

Takeoff power = 120 percent of m.e.p. power.

Cruise power for low speeds but corresponding at usual flight speed = 45 percent of m.e.p. power = 54.2 percent of takeoff power

Using the two formulas derived in following takeoff power loadings at wing loads are obtained:

Altitude	$\left( \frac{W}{S} \right)_{\text{cruise}}$	$\left( \frac{W}{S} \right)_{\text{takeoff}}$
Sea level	1.00	1.00
10,000 ft.	1.00	1.00
20,000 ft.	1.00	1.00

For the choice of a well-balanced design, wing loading must be related to the maximum lift coefficient available from the wing. For the maximum values, two some C.A.A. regulations may be used. C.A.B. 04752-T states that the stalling speed at landing weight shall not exceed 80 mph, while C.A.B. 04752-T specifies that the maximum takeoff weight shall not be greater than 1.15 times the landing weight. Use these regulations and the data from previous tables:

Altitude	$\left( \frac{W}{S} \right)_{\text{cruise}}$	$C_L$ max.
5,000 ft.	30.6	1.96
10,000 ft.	30.6	1.96
20,000 ft.	30.6	1.96

Maximum lift coefficients in high- $C_L$  can be obtained by careful wing design and prodigious use of high-lift devices. The maximum lift coefficient required for a transport designed for 25,000-ft. operation is a realistic value.

This analysis has been shown to demonstrate that the high power required by the dictates of the Civil Air Regulations, low safety, are not excessive in an airplane designed for high climb operation. Relatively high lift powers are required, not only for lift but also for maximum utilization of the range of cruising powers, starting with the maximum economical value per of the engine.

AVIATION'S New Regular Feature

## FOR Better Design

### WING FLAPS PERMIT QUICK AND SAFE PULLOUTS

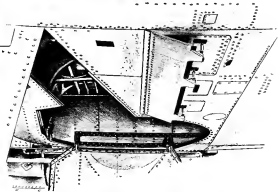
MODERN AIRPLANES have been using very high speeds at altitude, without compressibility effects, have recomputed wing characteristics to flight characteristics in a dive in which compressibility effects are encountered, and increased wing moment resistance to forward movement of the

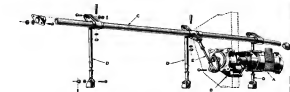
center of pressure on the wing when shock occurs, and (2) rearward movement of center of pressure on the elevators.

By designing compressibility dive flaps for the new P-47 Thunderbolt, Republic Aviation engineers have provided means to counteract these undesirable changes and afford safe pullouts at critical speed and high altitude

With the advent of heavy wing loading and good aerodynamic cleanliness, fighter planes have attained top speeds approaching that of sound. It is to be expected that all airplanes will run into difficulty—that is, exhibit unusual flying characteristics—at such speeds. The ratio of airplane speed to sound speed is known as the Mach number, and the same true airspeed corresponds to different Mach numbers at different altitudes (since speed of sound decreases from 763 mph. at sea level to 666 mph. at approximately 35,000 ft., above

Design here is P-47 Thunderbolt compressibility dive flap installation in extended position, with handle (top) visible at rear. Flap is located at approximately 30 percent of chord, rear wheel well. Flap open is 40 in. chord 6 in.





Exploded view of dive flap assembly showing: (A) Motor, (B) reduction gear housing, (C) torque tube, (D) transfer rods, and (E) actuator rod for torque tube, attached to indicator gear bell crank. Sketch at lower left shows relative position of stabilizer in wing.



which this speed remains constant.

Air flowing over a curved body experiences an increase in speed over that of the undisturbed air. Thus it may happen that although the speed of the body is not that of sound, the speed at some local point on the surface has attained this speed. Accordingly, the separation of the air adjacent to the airfoil breaks down, and there develops what is known to the aeronautist as a compression shock. The airplane speed at which this occurs is different for various bodies or airfoils, and the ratio of this speed to some speed is known as the critical Mach number, and is of great importance in all compressibility effects.

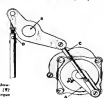
With the establishment of this shock wave, the flow over the wing, body, or tail surface changes in such way as to cause rearward movement of resultant loading over the surface, an increase in drag of the surface or body, and a lateral change in the width and degree of interference of the wake.

Because of increased diving resistance which results from rearward movement of the center of pressure on the wing when compressibility shock occurs, and the rearward movement of the center of pressure on the elevator, a greater force is required to pull out of a dive.

In a steady dive at high Mach number, it is likely that the horizontal tail surfaces will be in the thicker wake of the wing and therefore be subjected to buffeting. For the afterbody, or control surfaces, in which there is no tendency of the balance portion to penetrate into the free stream, the resulting change in loading over this portion may be such that rapid reversals of stick force occur. As a result of high speed and high wing loading, the following phenomena—which are direct effects of compressibility—have occurred in high-speed high-altitude dives with the P-47:

1. Rapid reversal of aileron stick forces when the controls are not neutralized.
2. Buffeting of the horizontal tail.
3. Freezing of the elevator control, exhibiting stick in the feeling as if the stick were set in concrete.

These are indications that compressibility is becoming a factor.



Detailed view of dive flap linkage showing: (A) Reduction gear bell crank, (B) torque tube, (C) actuator rod for torque tube, and (D) transfer rod for flap.

belly is buffeting after the onset of a dive, and that there is a possibility of the same existing at other parts of the aircraft.

It is imperative to note that the P-47 is an extremely responsive aircraft, and that it is capable of pulling out of a steep dive at critical speeds at altitudes between 20,000 and 37,000 ft. It is easily understood that compressibility is a factor in such a situation. When diving sharply to a speed of 400 mph at altitudes between 25,000 and 37,000 ft., the P-47 pilot may pass the energy step dive in excess of 10 g's without suffering damage and to have no value, the design should never be exceeded.

The pilot should not move from a half-stick, because the elevator may not have his control, and since he is pulling out at a greater rate than in a normal pull, the pilot should be warned that the elevator should be released.

3. The airplane should be designed so that the human element need not be concerned with either zero, or a slight positive, or negative, stick position.

4. No change in elevator control during the dive should be made. This is a condition which is not to be considered.

When an airplane is diving, the elevator is buffeted by the air. The elevator trim will not be affected by the air. As the airplane goes into a dive, the air pressure on the elevator is increased. The pilot should be warned that the elevator should be released.

and while the airplane was in a compressibility shock, the plane would be heavy as an aircraft attempts to pull out, he would be subjected to a dangerous and sudden shock when the craft reached normal compressibility shock speed. The pilot would then be required to use to correct this condition, and the pullout would be a dangerous high load pullout resulting in an accident to the plane and physical injury to the pilot.

The pilot should never suddenly be subjected to this condition, and the pullout should be a gradual one. The pilot should be warned that the pullout should be a gradual one. The pilot should be warned that the pullout should be a gradual one.

At altitudes above 30,000 ft., since the altitude is coming out of the dive is not a factor, but heavily loaded.

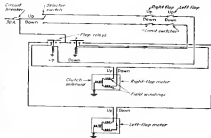
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Electrical circuit for dive flap actuation.

One dive flap is located under each P-47 wing just inboard of the wheel well. Constructed of 180-in. 24ST sheet, 40 by 6 in., each flap is hinged at forward edge to the wing, and is limited in travel to an angle of 21 in 3 deg.

The flap installation consists of:

- (1) The recovery flaps.
- (2) Two reversible electric motors, with gear ratio of 345:1, one located in each wing. The motor gear shafts are connected to the recovery flaps by means of a system of levers, rods, and torque tubes.

(3) A flexible cable, passing through the fuselage from wing to wing, connecting the two electric motors to assure flap synchronization. Couplings are provided in the cable between the wings and fuselage as

quick disconnect units for wing removal.

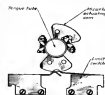
(4) Limit switches, actuated by Micromat cases, clamped to the torque tube, to break the circuit when the flaps reach the full down or up positions.

(5) A relay located in the main switch and circuit protector box, electric switch located on the left side of the propeller selector switch panel, and circuit protector located on the main switch panel.

When the switch in the cockpit is moved to either Up or Down, as the case may be, current is sent through the Up or Down limit switches in the main switch panel box. This, in turn, sends a higher current to the actuating motors.

The magnetic brake and clutch in the motors are released electrically, and the motors operate to move the flaps up or down. When the flaps reach the full up or down position, limit switches are actuated, breaking the circuit to the relay, which in turn, breaks the circuit to the motor. As the current ceases to flow through the motor assembly, the brake is applied to prevent overtravel and chatter.

The cockpit switch has no off position and must be kept in either Up or Down position.



Limit switch arrangement in cockpit which when flaps reach full down or up positions.

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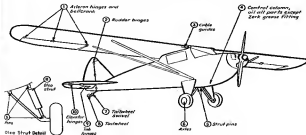
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 Engine oil is used every 75 hr at (1), (2), (3), (4), (5), (7), (9), and (10).

Hydraulic fluid of type specified for cylinder (11) is added as required every 100 hr. Center hose oil should be used if original rubber seals are installed.

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The first handmade experimental model flew in July, 1942. By the end of 1943 Hellcats were battle-famous. Today, thanks to the amazing Grumman production record, thousands of Hellcats roam the Pacific, their altitude, maneuverability, speed,

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**THE SHOCK IS BRUTAL** when a heavy Hellcat lands on the carrier deck. But U. S. Royal Airplane tires are needed for that kind of service. Their extra strong rayon cord construction provides the reserve strength that absorbs these shocks, their sharp edge blocks give the sure traction that holds the plane under control, brings it to a safe stop.



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**READY AT THE READY** for deadly blows at Jap planes, the Hellcat was the first American fighter to roll out of combat experience in World War II.



**GOING UPSTAIRS FAST.** The Hellcat flies in the 400-mile-per-hour class, fights at 35,000 feet and above and has a range of 3000 miles or more.



**WINGS FOLD BACK AS NEATLY AS A HIND,** making it possible to pack more Hellcats on the carrier deck, pack more punches when the battle starts.



**START OF A STRIKE**—this Hellcat gets the take-off flag. A belly tank provides extra fuel...but adds weight. Another reason why tires must be strong yet light.



**WHEELS DOWN, BRAKES ON, HOOK OUT**—this Hellcat returns to its "nest". As it "hits the deck" tires must have plenty of reserve strength to take the shock.



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### AVIATION ABROAD

Southwest Aircraft Corp. is in start production on 200 North American Aviation Model 180B, a two-engine, low-wing, single-aisle transport aircraft.

Interest in France in particular has been growing for the Model 180B, a two-engine, low-wing, single-aisle transport aircraft. The aircraft is being developed for the French market and is expected to be in production in 1945.

Pilot Argentine stated to be an outstanding example of aircraft production in Argentina. The aircraft is being developed for the Argentine market and is expected to be in production in 1945.

Spain, under recent transport restrictions, has reported to be an outstanding example of aircraft production in Spain. The aircraft is being developed for the Spanish market and is expected to be in production in 1945.

British government is stated to be an outstanding example of aircraft production in Britain. The aircraft is being developed for the British market and is expected to be in production in 1945.

English-occupied Southern Spain is stated to be an outstanding example of aircraft production in Southern Spain. The aircraft is being developed for the Southern Spanish market and is expected to be in production in 1945.

Germany, May 20, 1945. The Luftwaffe is stated to be an outstanding example of aircraft production in Germany. The aircraft is being developed for the German market and is expected to be in production in 1945.

Italy, May 20, 1945. The Italian Air Force is stated to be an outstanding example of aircraft production in Italy. The aircraft is being developed for the Italian market and is expected to be in production in 1945.

Japan, May 20, 1945. The Japanese Air Force is stated to be an outstanding example of aircraft production in Japan. The aircraft is being developed for the Japanese market and is expected to be in production in 1945.

China, May 20, 1945. The Chinese Air Force is stated to be an outstanding example of aircraft production in China. The aircraft is being developed for the Chinese market and is expected to be in production in 1945.

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measuring method of measuring shore  
sides, break, and marks of machinery and  
plans to reduce the concentration of  
arms in order of reports issued by  
the NRC Co., Cleveland.—AN IATON.  
(4, 4)

**Lock Washers** ..... 3  
Bolt-In Grom Metakromat, Inc., Chicago, makes description and illustrates uses of company's patented lock washers in construction for use with bolts, screws, rivets, washers, cable couplings, carrying systems and other applications. — A-21

Operations such as efficient shape rolling, stainless steel welding, and plate rolling on machines developed up to 1940 are in progress are shown by Institute, Industrial Steel Fabricators, from the National Fabricators Co., Fort Worth, Tex. 2-2711700. Engr. 30.

Reservative Glass for Sept-Oct. Issued by J. F. Louchie, Div. Montague Animal Co., Seattle, Wash., contains information on new waterproof and leak proof glass. (Louchie) 9792-C—AVIATION, Feb., 42.

—*Illustration, Feb. 10.*

chemical composition and oil permeability of several shovels were analyzed by Rockwell Petroleum Corp., Los Alamitos, Calif. are given in column 4 of table No. 1, A. Used where they are required to heat, corrective measures of drainage of fire hazard, however, is described as being dropped heat and oil.

42 Tool Lubrication ..... \$  
 Numerous types of magazine lubricants, used by The Viking Co., New York City, contain special additives that the lubrication of *Forwards Air Tools*—  
 VIKING, Inc., 15

These data have implications for the use of these insects in biological control. The insects are not as effective as previously reported, and the use of these insects in biological control should be re-evaluated.

**Category:** 01-17 From John S. Pearson  
**Cover:** Back cover of 21 American unit type  
**Reference:** 01-17 In name from 196 to 19  
**Notes:** 01-17 of system to a language

**KEEP POSTED ON**  
***Products and Practices***

**Mecklen Tool Catalog** .....11  
Mecklen Tool Co., Cleveland, offers new catalog containing complete information on line of rotary chucks, spinners, wrenching machines, and drill heads.....11

Adjustable drillheads of two or more  
spindles with quaternary lock are detailed in  
drawing from The Danalizer Products Co.,  
Boxer-Thomson Corp., Long Island City,  
N. Y.—AVIATION, Feb., p. 25.

**Million Machine Tools** ..... 1

**Heavy Duty Live Caster** . . . . . 18

**Test Outline** . . . . .

**X-Ray Spectrometer** ..... 57  
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584









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 Described are adaptable and inexpensive measuring apparatus, circuits, procedures, and other factors in the solution of practical electrical and electronic measurement problems. New procedures are presented for determining the time constant of an RC network, the inductance of a coil, and the capacitance of a capacitor. Also included are methods for determining the frequency of a periodic waveform and the period of a periodic waveform. The book is written for the student and the technician.  
 120 p., N. Y. — AVIATION, Pub. Co., 1964.

**Free-Air Thermometer**..... 2  
Designed for and supplied to AAF by  
Spartan Aviation Corp., Lebanon, N. H.  
Free-air thermometer is now standard  
instrument. Described as rugged, set in  
chrome, it may be mounted in free air  
—AVIATION, Feb. '42

**Carrier Flashes**.....

Designed for pitching letter heads, circulars, sample card, entry forms, etc., Tinsworth Products, Cleveland, are available in sizes suitable for letter mail, folders, mail in boxes, for business cards, menus and more. Sales, dist.

[illegible]

## ANNOUNCEMENTS

of new machine tools, shop equipment and materials, electrical appliances, and aircraft parts and accessories are lent for inclusion in these exhibits.

In writing, emphasize specific solution applications to newly-marketed items in drinks, and whenever possible glossy-print photos should be enclosed. Please do not send the press.

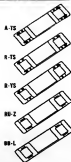
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Hyatt Hy-Load Bearings are made in separable types as well as in self-contained units. In the separable bearings the inner races are the separable units in one instance and the outer races in the other. Thus, the component parts of every separable Hyatt Hy-Load type bearing of a given size are fully interchangeable. Every race fits every roller assembly.

Separable races may be assembled in one part of the shop and the rest of the bearing in another. When the sub-assemblies are brought together on the final assembly line the component bearing parts will fit correctly. No selection or matching required.

Every Hyatt A-TS, R-TS, R-YS, BU-Z and BU-L type bearing has this feature—and many others. Write for data.



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**MECHANIC:** "Great loads, Pete... we almost never replace one!"

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In a remarkably short period of time, engineers and maintenance men have come to appreciate the outstanding performance delivered by Titeflex Unimold ignition leads. Introduced by Titeflex less than two years ago, today you'll find them in, among others, the Pratt & Whitney 3000, R3600, and R3300 series engines that power the C-54 Douglas Skyraider, Douglas C-47 "the workhorse of the Army", PB24 Consolidated Commodore, Consolidated B-24 Liberator (Army Version), Chance-Vought Corsair, Grumman Hellcat, Republic P-47 Thunderbolt, Northrop P-61 Black Widow and many others.

The reason that Unimolds have won can be traced to the sound, bedrock engineering that went into the development of the Unimold manufacturing process. By modifying the various elements of the lead internally... Titeflex engineers produce an assembly offering the very best mechanical and electrical characteristics in combination with absolute comfort, electrical conductivity and resistance to use only. Each assembly is subjected to thorough X-ray and electrical in-

spection tests before being shipped. Thus it is made absolutely certain that the conductor is molded in the precise form of the insulating compounds and that these vital ignition leads will not fail electrically in service.

Titeflex Unimolds perform equally well in auxiliary applications, and many of them are being used with gasoline driven generators and gasoline aircraft engines. Titeflex engines are available for consultation on any aircraft location or other shielding problem. A letter will bring you details.

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# Titeflex



## tells the WHY of Ball Bearings



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Place a ball on your desk. Push it with your finger. Then try to push it so that it rolls. You'll find that it's easier to push it so that it rolls than to push it so that it slides.



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Place a marble under the book. Push the book. You'll find that it's easier to push the book so that it rolls than to push it so that it slides.

There is a simple, fundamental truth in the principle of the ball bearing: "Nothing Rolls Like a Ball!"

The ball possesses inherent advantages unequalled by any other rolling body. There are no ends to a ball—so its axis of rotation need never be artificially fixed.

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That is why over 300 million New Departure Ball Bearings are at work in this war. That is why designers of peace-time machinery are designing more ball bearings into their machinery than ever before.

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PHOTOGRAPH FOR CALVER AIRCRAFT CO. BY ROBERT HARRILL BROWN

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The man who buys a plane—and his son—can profitably ask the question "Why?"

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Ask your aircraft parts supplier or write for this Sensenich literature. Model number, all aircraft finishing, processing, etc. to be used. Write to: SENSENICH PROP. CO., 1000 E. 1st Street, St. Louis, Mo. 63103.

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**Costs DOWN . . . Production UP . . . with the Closer Precision of Permited PERMANENT MOLD Castings**

★ The price of an aluminum casting is often only a fraction of the cost of finishing it. And it is in reducing your finishing cost that Permited Permanent Mold Aluminum Castings offer you important savings. Permited mold castings are more precise in dimension (tolerance is  $\pm .01$ " against  $\pm .05$ " in sand castings). And because every casting is poured in the same permanent metal mold, all castings are dimensionally uniform.

These cost-saving precision features mean less rough weight in the casting — less metal to remove. You do not have to readjust finishing machines to meet variations in the castings. Even automatic, multiple-operation machines can be safely used with Permited Permanent Mold Castings. You may also have fewer surfaces to machine; the finished cost per casting is often surprisingly low.

Aluminum Industries' first products — 25 years ago — were permanent mold aluminum castings. Today, no foundry is better equipped to turn out castings of this superior type. Experience has given us a thorough knowledge of aluminum and its alloys. And the specialized knowledge of our engineering staff is always at your service. We shall be glad to submit recommendations, upon request.



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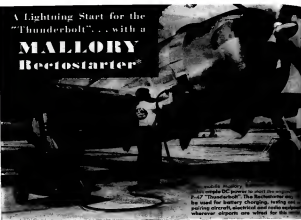
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Portable Mallory Rectostarter supplies DC power to start the engine of a Republic P-47 "Thunderbolt". The Rectostarter may be used for battery charging, testing and pairing aircraft, electrical and radio equipment wherever airports are wired for this service.

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**S**TARTING the 2000-horsepower engine that powers a Republic P-47 "Thunderbolt" is now easy with DC current supplied by a dependable Mallory Rectostarter.

Mobile, rugged, easy to operate, unaffected by variations in the weather, the Rectostarter is built to give years of trouble-free service. They are built to operate from any 208 and 250 or 460 volt 3 phase 60 cycle AC source to furnish an economical, continuous flow of DC power. Rectifying action is provided by Mallory magnesium-copper sulphide rectifiers. With no moving parts, these dry disc rectifiers assure silent operation and long life.

Republic Aviation Corporation—like other air-

craft manufacturers and the airlines—find many uses for Mallory Rectostarters. Starting engines... providing power for radio, instruments, lights and other equipment in the plane while on the ground... testing aircraft engines and electrical equipment during manufacturing operations... these jobs are commonplace for the Rectostarter. All this and battery charging, too, for it can be used to taper charge 12 and 24 volt aircraft batteries without removing them from the plane... wherever the airplane may be an airport wired for this service.

Rectostarters are available in portable or stationary units, with one or more DC outlets. See your nearest Mallory Distributor for details. Or write us today.

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MAGNESIUM COPPER SULPHIDE RECTIFIERS—  
STATIONARY AND PORTABLE D. C. POWER SUPPLIES—  
BATTERY CHARGERS AND AVIATION RECTOSTARTERS\*



## PRODUCING WING SPARS ON SHORT ORDER

By WILLIAM WINTER

Editor of "Air Trails" and author of "War Planes of All Nations" tells how Bell Aircraft has developed a spar milling machine that in twenty-two minutes does the job that once required twenty-four hours.



**T**HE Bell-designed spar milling machine is one of the great contributions this progressive company

has made to speed up American aircraft production. Previous to the development of this mill, men being used

by Bell and many other aircraft companies, it required twenty-four hours to complete a wing spar. Now these expensive machines, covered by Bell Aircraft patents, turn out the spars for the giant Boeing B-29 Superfortresses being built in the massive Bell Aircraft plant in twenty-two minutes.

"The Bell spar milling machine, first developed in 1940, makes a cut two inches deep and four inches wide at the rate of ninety-five inches per minute.

"Under the old, slow method the material was fed into stationary cutter heads. In the Bell-designed mill the cutter moves across the metal, which is securely held to a bed so slumps that automatically drop down to let the cutting machinery pass and then jump up to grip heads the spar has finished the moving process.

"Since the cutting head runs on a cam which acts as a dial, the machine can vary constant up to twenty degrees.

"Each machine is its own automatic housekeeper, for streams of coolant pumped onto the high speed cutter heads sweep away the shavings and deposit them into a central sump pit.

"The advanced design which Bell engineers have built into this spar milling machine are further evidence that American 'know how' is the prime factor that now makes this country the greatest air power in the world.

"And when Valley down, this same engineering ability will be utilized in producing peacetime products that will bring that nation better living and greater values."

★ Buy War Bonds and Speed Victory ★



MINOR AIRCRAFT WAS PRODUCTION LOUNGE... EAST COAST, INC.

**BELL Aircraft**

FACE-MAKER OF AVIATION PROGRESS

AVIATION, February, 1943

**MAGAZINE PROMOTION DIVISION**

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B-29 Boeing Superfortress

## A MICA MINE IN A LABORATORY



War shortages crop up in strange materials. Mica, for instance. Once seen principally in the windows of stores, and in small boys' pockets, it is now used extensively as electrical insulation. In some war products, it is virtually indispensable: capacitors for radios, spark plugs for airplane engines, insulators in electronic tubes.

With demand mounting, manufacturers were desperate. A four-man

technical mission flew to London to help restore the world's supply between the United States and Great Britain. The shortage was serious.

The War Production Board, convinced that much mica was classified too low when judged by appearance alone, asked Bell Telephone Laboratories to develop a new method of electrical tests. The Laboratories were able to do this quickly and successfully

because of their basic knowledge and experience in this field.

The new tests were made available to manufacturers in the country as abroad—the supply of usable mica increased 60%—and a difficult situation relieved.

Skill to do this and other work is at hand in Bell Laboratories here year after year, the Laboratories have been at work for the Bell System.

BELL TELEPHONE LABORATORIES



Exploring and inventing, designing and perfecting for our Armed Forces at war and for continued improvements and advances in telephone work.

AVIATION, February 1945



## MR. ENGINEER...66 years is a lot of leather

In 66 years of processing leather to protect and seal machine parts, Chicago Rawhide has solved again and again the toughest problems posed by the inventive genius of America's top industrial engineers. Three factors are responsible for the success of Sirvis leather products... the solid foundation of knowledge about mechanical leather which is Chicago Rawhide's greatest asset... the custom-built designs developed by research engineers who have learned that each new problem needs special consideration... and the rigid laboratory control in every stage of production, which means absolutely uniform performance under all service conditions.

If protection is your problem, why not draw upon this unparalleled reservoir of specialized engineering experience? If your problem designs include parts where irregular, eccentric or universal action makes a rigid seal impractical... a Sirvis leather boot may be the answer. If unusual precision, resilience, long

service or resistance to pressure, shock, or vibration is demanded in packings, washers, gaskets, couplings or valve discs... Chicago Rawhide research can develop the properties you require, and careful production control can assure the most exact processing. For precision performance in protective coverings and seals, specify Sirvis mechanical leather.

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AVIATION, February, 1945



## HOW TO TURN A PANCAKE ... into a perfect 3-point landing!



No need for a perilous pancake landing when a fighter plane returns to base—though enemy bullets may have weakened the hydraulic supply line that controls the retractable gear.

Aboard the plane, there's a compact storehouse of emergency power—a Kiddy cylinder of compressed carbon dioxide! The pull of a handle releases the stored energy of this highly compressible gas—sends carbon dioxide coursing through an emergency supply line to operate the retractable gear.

Down come the wheels for a routine 3-point landing.

This is one of the many tasks that give under-pressure, stored in light-weight Kiddy cylinders, are performing in the aviation industry. Specialists in power actuation by compressed gases, Kiddy engineers are ready to work with you in adapting this compact source of energy to your specific problems. Just drop a line to our Research and Development Department.



Walter Kiddy & Company, Inc. • 140 Cedar Street, New York 6, N.Y.

# Are You Doing It *This* Way Now?

LET'S SEE... I NEED A 1/2" SOCKET ON THAT NUT... BETTER USE MY 3/4" DRIVE BECAUSE THIS IS GOING TO BE A HEAVY PULL.

**(A) The Heavy Pull**

HM-M. HI NAW! ANOTHER 1/2" NUT — BUT NOW I BETTER SWITCH TO MY 1/2" DRIVE BECAUSE A 3/4" DRIVE NUT UP WOULD NEVER GET IN THERE.

**(B) The Tight Spot**

## Here's How You'll Want to Do It After the War

### —When You Can Buy **NUGGETS!**

His picture shows you at work on the same tough job, but as in (A) above. But now you're armed with NUGGETS! Socket Wrenches having a 7/16" drive.

WANT THIS COMBINATION? IT DOESN'T AS A PROBLEM, BUT THE GUY TO STAND THE HEAVIEST PULL I CAN GET IT.

**(C) The Heavy Pull**

Now — you shift out to that tight spot as in (B) in (A) — but you don't have to go to a hardware and waste a couple of bucks. You use the same 7/16" drive as in (C). NUGGETS are compact enough for these cramped quarters.

YES! SEE! NUGGETS IN ONE DRIVE DO THE SAME WORK THAT ONCE MADE ME HAVE WRENCHES IN BOTH 1/2" AND 3/4" DRIVES.

**(D) The Tight Spot**

**TAKE a look at your assortment of socket wrenches, today! Aren't many of the sockets the same in both the 1/2" and 3/4" drives? And your handle types—catchers, speeders, extensions—are also duplicated? How would you like to own Socket Wrenches in One DOUBLE-DUTY DRIVE which makes it unnecessary to keep both 1/2" and 3/4"?**

Well, you can have such miracle wrenches—after the war when Blackhawk will make NUGGETS again. Don't buy old-fashioned wrenches unless you absolutely need them. Wait for NUGGETS! They're worth waiting for! Ask any mechanic who owns a set of NUGGETS!

**A Product of BLACKHAWK MFG. COMPANY, Dept. W125, Milwaukee 1, Wisconsin**

(TO PRESENT NUGGET OWNERS: If you have lost any of your 7/16" drive sockets, Blackhawk will, for the full cost, deliver the replacement. Blackhawk wishes to protect the delivery of present owners, through their 1/2" drive sockets, and will sell on a new basis after the war.)

## BLACKHAWK

WRENCHES THAT SMASHED TRADITION

**SOCKET WRENCHES**

1/2" DRIVE 3/4" DRIVE 1/2" DRIVE

Don't Buy Two Sets When One Will Do the Job!

## Engineering Vision... Manufacturing Precision



In ships at sea, in fighter and bomber planes, at command posts and in other war vehicles... Delco Radio products are carrying out vital assignments. For the fighting forces. They represent the application of radio and electronic science to varied requirements of communication, detection and protection. They represent, too, the effective combination of engineering vision and manufacturing precision that underpins the performance of all Delco Radio equipment, wherever it serves and whatever its purpose. Delco Radio Division, General Motors Corporation, Kalamazoo, Indiana.

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BUY MORE WAR BONDS

## CUTS THEM FASTER

Aluminum Armor Plate  
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Aluminum, 14 ST.  
Aluminum, 24 ST.  
Aluminum, Ingots  
Aluminum, River Kings  
Brass, Yellow  
Brass, Ingots  
Bronze, Monoplane  
Bronze, Teapoly  
Copper, Beryllium  
Copper, Forged  
Iron, Gray Cast  
Kevlar  
Lead  
Magnesium, Alloy  
Magnesium Crystals

Celluloid  
Ethanol  
Fenite  
Fenite  
Zinc  
Saron  
Rubber  
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Consider our modern laboratory as your own. Send in sample of any hard-to-cut material and our engineering staff will get busy and give you a written report of findings and recommendations.

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203 N. Laurel Ave., Des Moines, IA.





**How a Penny a Day  
Kept Trouble Away!**  
(And Why Potts Wants Another CRESCENT)

TWENTY-TWO YEARS AGO, the HARRY T. POTTS Company, Philadelphia, purchased this Crescent Electric Tractor and has used it steadily ever since. That's a lot of service and, undoubtedly, it would mean a lot of tractor parts replacements. But this was a CRESCENT Electric Tractor!

Total tractor parts replacement bill for the entire twenty-two years was only \$56.90 — about a penny a day!

That's a phenomenal record for any type of mobile equipment. Because of that record, Potts has just purchased a new NEW Crescent Electric Tractor. It's this kind of service that explains why customers continue to buy Crescent Electric Trucks and Tractors.

**Total Accessories Costs  
for 22 Years**

Battery and two replacements are, of course, beyond control of the tractor manufacturer except for the initial equipment. Yet smooth Crescent performance was provided. From with a big saving on these accessories. Average used battery and tire costs for the twenty-two years were as follows:

2 Batteries . . . . .	\$400.00
2 Sets of Tires . . . . .	126.00
<b>TOTAL, 22 years . . .</b>	<b>\$526.00</b>
<b>Cost per year . . . .</b>	<b>\$ 23.91</b>

Total costs per day for tractor parts, batteries and tires averaged less than 1¢.

The Medium Crescent MW Two-Wheel Tractor, Designed to Trench, Level, Grade, Backfill, Hauling, etc. — It is flexible. Tests showing wheel operation parts operation where equipped with and service since showed great flexibility. Good for business.



CRESCENT TRUCK COMPANY 1120 Willow St., Lebanon, Pa.

**Crescent**  
**ELECTRIC TRUCKS AND TRACTORS**  
Industrial Truck and Tractor Specialists Since 1917

AVIATION, 1940



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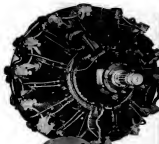
GENERAL AIRCRAFT  
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SOUTH NORWALK, CONN.  
TOOL DIVISION



• LEARN ABOUT THIS NEW SUPER HIGH SPEED STEEL WITH ALL THE DISTINCTIVE FEATURES OF CENTRIFUGALLY CAST ALLOYS, WITH HIGH WEAR RESISTANCE DUE TO THE PRESENCE OF BORON AND WITH MAXIMUM RED HARDNESS IMPARTED BY TWENTY PER CENT COBALT •

**GENERAL AIRCRAFT EQUIPMENT, INC.**  
SOUTH NORWALK, CONNECTICUT • TOOL DIVISION

AVIATION, 1940



PRATT & WHITNEY  
TWIN WASP  
ENGINE

**Lawson**

ALL OVER THE WORLD ..

IT'S LAWSON **PRECISION**

• Power! — Titanic power dependable, durable! That's the Pratt & Whitney "Twin Wasp"! What makes this power dependable and durable? The answer — quality precision machining of the maze of intricate parts.

• Lawson is proud to have been selected by the famous Pratt & Whitney Aircraft Division to manufacture vital parts for these engines. Lawson is ready and able to work with you on future plans that require close tolerances — the stepping-stones of mechanical progress.

*Charles M. Lawson*  
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SYMBOL OF PRECISION

**LAWSON MACHINE**



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MALDEN, MASS.

*Improved*

**AVIATION FITTINGS**



In addition to a complete line of fittings, Weatherhead makes valves, industrial hoses, hydraulic cylinders and other parts for these industries.

AUTOMOTIVE  
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THE WEATHERHEAD COMPANY, CLEVELAND 4, OHIO  
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In tremendous haste have been the wartime productive capacities of the four Weatherhead plants that we now have available for immediate delivery the greatest assortment of improved A-N Fittings of all types and sizes that we have ever been able to offer during our long experience in the aviation field. Take advantage of this situation by writing for our newest Surplus A-N Stock Catalog today.

MAJOR OFFICES: NEW YORK • PHILADELPHIA • DETROIT • BIRMINGHAM • ST. LOUIS • LOS ANGELES

WIRELESS, February, 1945



### HOW ALUMINUM BRAZING SIMPLIFIES ODD SHAPES

Until recently heat transfer units have been complicated by special reinforcements to give them strength in unusual shapes. At high temperatures the soft solder, which bonds copper tubes to these shells and to each other, could not stand the severe stresses set up by pressure, vibration and shear in unusual shapes, unless other weight-increasing supports were added.

#### ALUMINUM BRAZING CHANGES ALL THAT

Discovery of a way to lease thin-walled aluminum tubes to aluminum header plates and shells made simply constructed odd shapes possible, for three reasons:

1. Aluminum alloy bonding material defies temperatures, pressure and strains several times higher than soft solder can stand.
2. Heat-treatable aluminum alloy tubes, header plates and shells stand temperatures and pressures that cause copper to anneal and weaken.
3. Aluminum's weight being  $\frac{1}{3}$  that of copper affords other obvious advantages to designers of products incorporating heat transfer units.

That's why USAAF designers were quick to take advantage of Clifford's discovery and put Feather-Weights to use in a number of their aircraft models.

#### POSTWAVE PLANNING

Now war orders average 100% of Clifford's production... but inquiries and suggestions about postwar applications of all-aluminum heat-transfer units are automatic. Heating, cooling and ventilating fields are welcome. Clifford Feather-Weights... Send to the supplier... name and address. Clifford Manufacturing Co., 80 E. First Street, Boston 27, Mass.

# CLIFFORD



**OIL COOLERS AND COOLANT RADIATORS**  
**HYDRAULICALLY-FORMED BELLOWS**



### IN HYDRAULICALLY- FORMED BELLOWS *the metal has to be right*

Metallic bellows can be made four ways:

1. Built up from a number of sections.
2. Mechanically spun from a welded tube.
3. Mechanically spun from a seamless tube.
4. Hydraulically formed from a seamless tube.

The first and second are as strong as their metal at joints; the third is its test-scratched metal; the best is the metal only.

In hydraulically forming a bellows, no spinning touches its surface. It's made by forcing the part-thin walls of a metal tube between the plates of a collapsible die by means of internal hydraulic pressure. And since that pressure is much higher than any pressure it will meet in service, any bellows that sees the forming process must be metallurgically sound.

Therefore, to make hydraulic forming practical in metal from which the tube is made must be the best and the tube must be free from draw die marks, variations in wall thickness or faulty crystalline structure.

Clifford, being the first to produce hydraulically-formed bellows for industry, not only realizes the importance of metal selection, but also appreciates its critical nature of all processes involved in making its own assemblies for controlling temperature and pressure for sealing against pressure leakage, or for other exacting uses. First with the Facts on Hydraulically-Formed Bellows, Clifford Manufacturing Co., 80 E. First Street, Boston 27, Massachusetts.

## FASTER FINISHING WITH CLECO LIGHT GRINDERS



• For finishing forgings, dies, metal patterns, castings and similar work, you can't beat Cleco Light Grinders. They are light in weight, small and easily handled, yet pack plenty of power. The No. 234 series of Cleco Grinders is available at speeds of 14,000 and 18,000 R.P.M. and are governor controlled, while Model 12 is faster at 20,000 R.P.M. Fitted with  $\frac{3}{8}$ ", 24 S.A.E. thread spindles. Exhaust deflector included.

Standard equipment consists of spindle nut and washer, and  $\frac{1}{8}$ " collet chuck. Spindle extension  $1\frac{1}{2}$ " or 3" long furnished, in lieu of collet chuck, when specified. Dead handle supplied when so ordered.

Bulletin 60 describes these light grinders in detail, as well as furnishing complete data on the entire line of Cleco Rotary Grinders. Ask for it!



Working needs a coating.



Above, a Cleco 2347 light grinder. Below, a Cleco No. 234 assembling up an aluminum casting, with a rotary file.

## THE CLEVELAND PNEUMATIC TOOL CO.

375 East 77th St. • Cleveland 5, Ohio Branch Offices in All Principal Cities

# MAKING GLIDER PRODUCTION

# SOAR!



**WINGS FOR 18 FLYING DODGERS!**  
A new CG-15-A troop-carrying glider being flown away from Waco Aircraft's Troy, Ohio, plant.



**SPRAYING SHERWIN-WILLIAMS HOT DOPE ON THE WING** with the Sherwin-Williams perfected Thermotite® machine.

**Easy to use and simple to maintain**, the Thermotite® unit substantially cuts the number of doping coats required.

## SHERWIN-WILLIAMS



**1ST COAT OF DOPE** applied to wing sections acts as an adhesive for the "skin" of P'DF® (Pre-Doped Fabric). Thermotite® speeds the impregnation and does job more thoroughly.



**2ND AND FINAL COAT** is cross-laid over the "skin" of the wing, substituting the doping job and fully preparing it for coating with Sherwin-Williams Olive Drab—Thermotite® applied!

## THERMOTITE\* PROCESS

**slashes production time on new WACO troop-carrying glider!**

Only two coats of dope required! Production time doubled! That's the big news to come from Waco Aircraft's application of Thermotite\* in the manufacture of the new CG-15-A troop-carrying gliders!

On fuselage, tail and wing structures, tapes are applied with Sherwin-Williams cold dope or P'DF\* (Pre-Doped Fabric) and are sealed by a cross-coat of hot dope applied with the Thermotite\* unit. The doping job is completed with a single coat of Sherwin-Williams Olive Drab fed through the Thermotite\* machine. The body of the glider is ready for assembly.

The wings, built of precision plywood, are ready to go through a sealing process. A coat of

Sherwin-Williams hot dope is then Thermotite\*-applied...forms a perfect adhesive for the "skin" of Pre-Doped Fabric. A cross-coat of clear hot dope and a single application of Olive Drab follow.

Here's another example of how Thermotite\* eliminates need for thinners and effects revolutionary savings in time and labor. Want complete details? Just write today to The Sherwin-Williams Co., Cleveland 1, Ohio.



Patented in U.S.A. and Foreign. Thermotite\* Trade-Mark Reg. U.S. Pat. Off.

## AVIATION FINISHES

1147103, February, 1941

"I AM PART  
OF THAT SHIP"



### Delco-Remy Aircraft Electrical Equipment

With grease on his hands and hope in his heart, the man who gives a part of himself to every patch and repair "sweats out" his mission on the ground. He gets no glory, no battle honors. His reward is the sight of a plane returning safely, and the confidence of officers and crew in his skill. Delco-Remy electrical equipment is serving today in America's heavy and medium bombers, carrying out its part in a large assignment. More than half of Delco-Remy's facilities are engaged in the manufacture of electrical units, precision parts and products for the aircraft industry. When Victory is finally won, Delco-Remy equipment will help maintain the dependability of commercial aircraft and bring the convenience of dependable electric starting, lighting and ignition to light plane owners.



**DELCO-REMY**

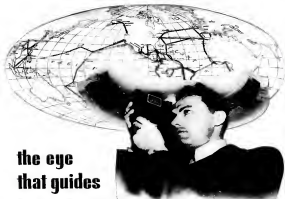


DIVISION, GENERAL MOTORS CORPORATION

AVIATION, Detroit

## Bombers Roll and Fly

**ON BOWER ROLLER BEARINGS**—On the runway or in the air, Bower Roller Bearings carry the rolling load of the big bombers—in the engine, in the controls, in the landing wheels and other locations. World War II is a war on bearings.



the eye  
that guides



wings over the world

The global air routes pioneered by Pan American World Airways have proved to be of outstanding importance to our war.

When the Japs struck at Pearl Harbor, PAA routes were immediately available for the use of our Armed Forces. Today, as the war draws to a crisis, PAA flight crews are serving both the Army and Navy in flying personnel and material to every theatre of operations of our world-wide battlefronts.

And the PAA navigators, operating under the Mimeo based Air Transport Command, are busy baring their calculations on the readings of the Fairchild Aerial Sensus — a sensus that has the full confidence of men who know the skies.

And sightfully so. For Fairchild Aerial Sensus was developed from a basic design suggested by the U. S. Army Air Force to be compact, lightweight, easily handled, with a bubble that streams "sensus" — with successive series of consecutive sights during the entire sighting operation.

Fairchild leadership in the design and precision production of aerial operations instruments — which include sextants, cameras, radio direction finders, lead computing sights — is the reward of its air-minded policy of expansion and building far beyond the stated basic specifications of a given problem. New York Office: 475 - 10th Ave., New York 18, Plant: 88-06 Van Wyck Blvd., Jamaica 1, New York.

AERIAL  
SEXTANTS

*Fairchild* CAMERA  
AND INSTRUMENT CORPORATION



## FORMATIONS FOR VICTORY



B-24 Army Air Corps Photo



LOOK at a perfect formation of fighter planes in the sky... and you'll see the significance of a "formation" of drums on a beach head. Inside those drums is the fuel for victory in the air. And to guard that fuel — to keep it safe from seepage, dust and contamination — is the war-time job of Tri-Sure Closures.

The critical needs of war have proved repeatedly what every user of drums should know: if Tri-Sure Closures are on a drum head, every drop inside that drum is safe. The reason is that Tri-Sure Closures seal a drum hermetically with a seal, plug and flange that no water or impurities can pass.

This is Tri-Sure's famous triple protection that enables drums to be stored in the open for months, or shipped thousands of miles, without leakage, seepage or loss. And that is the kind of protection that every drum in every shipment should have.



AMERICAN FLANGE & MANUFACTURING CO. INC., 20 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.  
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

©1945, February, 1945

in there—Pitching

Every man on the job at Olofsson's knows what PRECISION means. They take pride in quality performance as designers and builders of tools, dies, jigs, gages, fixtures and special machines.

*Olofsson*  
TOOL AND DIE CORP.  
LANSING, MICHIGAN

CHICAGO ENGINEERING OFFICIALS BLDG. MICHIGAN ST.

AVENUE 7th Floor

# 2.5 HORSEPOWER PER POUND

IS THE OUTPUT OF THIS

## VICKERS AIRCRAFT HYDRAULIC MOTOR

(PISTON TYPE  
CONSTANT  
DISPLACEMENT)



This Vickers Aircraft Hydraulic Motor weighs only 6.4 pounds yet it has a normal output rating of 16 horsepower at 3000 psi and 3750 rpm.

But a high horsepower/weight ratio is not the only advantage of using Vickers Hydraulic Motors for delivering rotary mechanical motion on many aircraft applications. These hydraulic motors save space as well as weight. Starting and stalled torque both closely approach operating torque. They can be stopped accurately to position. . . . No clutches or brakes are required. They are used for dynamic braking and can be stalled for long periods without

damage. These hydraulic motors can be started and stopped instantly due to the very low inertia of the moving parts. They cause no radio interference. Reversal and accurate control of speed are very simple and easily accomplished.

Vickers Aircraft Piston Type Hydraulic Motors are inherently simple and rugged; they are available in a wide variety of models for operating pressures up to 3000 psi.

VICKERS Incorporated • 1462 OAKMAN BLVD. • DETROIT 32, MICHIGAN

Engineers and Builders of Oil Hydraulic Equipment Since 1921

14600, February, 1965



# NITRALLOY STEELS

**BAR • BILLETS • SLABS  
PLATES • SHEETS • STRIP**  
*in all commercial sizes*

**WE** are in excellent position to furnish the complete line of special alloy steels most suitable for case hardening by nitriding.

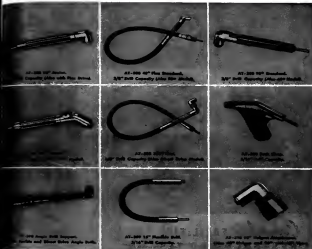
These Nitralloy Steels are produced both in our Chicago and Pittsburgh mills. Our metallurgists will gladly discuss their application in terms of your requirements.

(If you are not equipped to handle nitriding in your own plants we will gladly tell you what firms in your vicinity are qualified to do this work for you.)

**CARBON-ILLINOIS STEEL CORPORATION**  
Pittsburgh and Chicago  
Columbus Steel Company, San Francisco  
Pacific Coast Distributors  
United States Steel Export Company, New York



**UNITED STATES STEEL**



## AN AIRCRAFT TOOLS ANGLE DRILL

*for Every Purpose!*

Aircraft Tools Angle Drills and Flexible Shafts are designed for aircraft fabrication and are ideal wherever power transmission is a load and is required. They are rugged—precision-built to give long, trouble-free service under the most wearing conditions. Full radial ball bearing construction throughout. Drive shafts and spindles are made of carefully ground heat-treated alloy steel. All angle drills and attachments are "broken in" and tested on a specially designed test stand before delivery.

Shown are only a few of the sizes and types available. For complete information, please write for our catalog.

**Aircraft**  
TOOLS, INCORPORATED

**Complete Repair Service for All Types of Aircraft Tools.**



## Complete FACILITIES FOR RESEARCH AND TEST ON TUBING PROBLEMS . . .

Day in and day out, in a spacious building with complete and modern facilities, Globe chemists and metallurgists conduct research on tubing problems. Testing and inspection of Globe Steel Tubes are regular routine. Special problems of customers are studied, too, and physical and chemical tests, spectrographic and microscopic examinations are made, to select the correct analyses for each customer's particular needs. The Globe technical staff is available at the mill or in the field, for technical service on tubing problems.



A typical special report, prepared by the Globe Laboratory and returned to the customer.



- Boiler and Pressure Vessel Tubes
- Condenser and Heat Exchanger Tubes (Seamless)
- Backsaw and Open End (Seamless)
- Hydraulic and Pneumatic Cylinders
- Steam and Hot Water Pipes
- Gas and Air Pipes
- Shipbuilding Tubes

**GLOBE STEEL TUBES CO.** Milwaukee 4, Wisconsin, U. S. A.

**LOW WEIGHT...  
COMPACTNESS**  
for your *New* PRODUCT

WITH A  
**Lamb Electric  
MOTOR**

D. C. Motor with A. C. take-off, especially developed for a portable aircraft engine heater.



Insurmountable high torque motor with low weight factor, developed for aircraft service.



Small, sturdy motor especially designed for aircraft heater service but can be readily adapted to a wide range of industrial applications.

Compactly designed motor developed for device measuring pump and special instrument service.



Base-mounted, explosion-proof aircraft geared fuel transfer pump motor. Precision built with compactness and dependability.

**Lamb Electric**  
*Black & Docker Electric*  
FORMERLY  
**SPECIAL APPLICATION  
FRACTIONAL HORSEPOWER MOTORS**

*Fitted to*

ONE OF BRITAIN'S FOREMOST FIGHTERS

# 5-BLADE

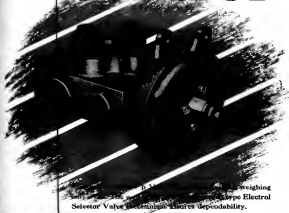
'CONSTANT SPEED'  
VARIABLE PITCH PROPELLER



**ROJOL**  
LIMITED ENGLAND

*Designers and Manufacturers of*  
**ALL-BRITISH** CONSTANT SPEED  
VARIABLE PITCH  
PROPELLERS

# control



weighing  
only a few pounds, the Electrol  
Selector Valve guarantees dependability.

## ELECTROL'S FOLLOW-UP VALVE

Originally designed for Wing Flap  
installation, it is equally valuable to  
such other uses as carburetor, rudder  
or any service where smooth, accurate  
and complete control is required.

Electrol engineers will welcome an opportunity to de-  
sign a Follow-Up Valve installation for any service in  
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 **ELECTROL**  
HYDRAULICS

ELECTROL INCORPORATED • KINGSTON, NEW YORK • HYDRAULIC EQUIPMENT FOR AIRCRAFT  
NAVIGATION, February, 1945

Relining cargo spaces with

# FIBERGLAS\*

REINFORCED PLASTICS SHEETS

- Gives  
Greater Resistance  
to puncture  
Better Appearance  
Light Weight

Former Metal Liner



Light, Strong Fiberglass Reinforced Plastic Liner

Pennsylvania Central Airlines is using this, strong, Fiberglass-reinforced plastic laminate in the reconditioning of the transport planes which the Army has released for commercial use.

The sheets, one-sixteenth of an inch thick, are made of layers of Fiberglas cloth bonded and impregnated with one of the new castable-resin systems.

Used to protect the fuselage skin from damage which might result from the loading and unloading of heavy cargo items, this material has greater impact strength and is lighter in weight than the corrugated metal formerly installed. The combination of Fiberglas and certain types of resins, results in a material having many superior physical and mechanical properties. It has excellent dimensional stability under a wide range of temperature and humidity changes. It has high sound dampening qualities important in aircraft construction.

Other types of Fiberglass (fiberglass glass in various forms) are being used by the military and commercial aircraft industry for both new construction and reconstruction work. A few of the types and uses are listed below.

If you do not have complete data on Fiberglass in all of its various forms, or if you have a problem which Fiberglass may help solve, write Owens-Corning Fiberglass Corp., 1891 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglass Canada Ltd., Oshawa, Ontario.



1. AIRCRAFT REINFORCED PLASTIC PARTS—Reinforcers are combining various low-pressure resins with Fiberglass fabric. Lightweight impact strength, sound dampening, bond for panels and floor mats.



2. AIRCRAFT BLANKETS—for thermal insulation. Fiberglass lightweight sheets of Fiberglass reinforcing mat, faced with Fiberglass cloth and coated with Fiberglass Resin.



3. AIRCRAFT CAPS—another lightweight product, woven from Fiberglass yarn. Removable. Used for insulating motors, generators, etc., and for lagging of electrical insulation on doors and pipes.



4. AIRCRAFT COATED PARTS—Fiberglass cloth used as a base for resin, is impregnated and other coatings. Greater strength, high strength, highly resistant to flexible construction, etc.

# FIBERGLAS

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# KEY TO A PERFECT FINISH

CHICAGO

GRINDING WHEELS  
AND MOUNTED WHEELS

Chicago Wheel takes pride in providing you with exactly the wheel you need, for exactly the job you have, to give you exactly the finish you want.

There's half a century of experience behind this, fifty years of specializing on grinding wheels—grinding wheels with hundreds of varieties in shape, size, abrasive and bond formulas, engineered for the right tool speed and work pressure.

**Come to Headquarters**—Our long experience and testing laboratory are at your service, free for the asking. Tell us about your tough grinding or polishing job. Our abrasive engineers will report promptly, give you their tested solution.

**TRY ONE FREE**—A Chicago Mounted Wheel or an PV Bond Grinding Wheel sent promptly on request. Tell us size preferred and what you have to grind.

**CHICAGO GRINDING WHEELS**—For the duration, sizes up to 36" in diameter only, in various bonds including PV, the bond with a pedigree.

**CHICAGO MOUNTED WHEELS**—For internal or external grinding, boring and polishing. Made to fit any tool, steady job, shapes and chuck sizes.

Send for Illustrated Catalog

**CHICAGO WHEEL & MFG. CO.**  
1101 W. Monroe St., Dept. AV Chicago 7, Ill.

Send catalog: interested in

- ☐ Mounted Wheels
- ☐ Grinding Wheels
- ☐ Bond Test Wheel

Size

Name

Address

## A New Vacuum Switch KEYING RELAY

.... for Aircraft and  
Other Applications

Here is convincing proof that a keying relay does not have to be complicated to be efficient. In fact, just the reverse! Actually, the extreme reliability with which Struthers-Dunn Type 78CCA100 Relay holds its adjustments is the direct result of its new simplified and rigid design which utilizes an absolute minimum of parts.

Originally made for aircraft use, it weighs little, is exceptionally sturdy, and has all parts readily accessible. Tests show a minimum life of five million operations.

The Relay has seven poles, including one double-throw pole which handles high-voltage radio frequency currents by means of a vacuum switch. All high-voltage parts are rounded to reduce corona.

Write for complete details, or get in touch with your nearest Struthers-Dunn Field Engineer.

**STROTHERS-DUNN, Inc.**  
1201 ARCH STREET PHILADELPHIA 7, PA.



# STRUTHERS-DUNN



The U.S.O. hostess recognized wings, and said, but the face was too young for the silver leaf on his shoulder.

"Heavenly day! . . . How do you Air Force boys run up so much rank so fast?" she asked.

"You just have to keep on brin', ma'am," said the youthful 8th Air Force Lieutenant Colonel . . . and he wasn't being at all facetious!



Since last summer they have been trickling back... with roses of ribbons under their wings, foreign service stripes, and the shoulder patch with the "G" between the spread wings of the Air Forces emblem. Two few of us know either the marking or its meaning.

The 8th Air Force began with the first few Flying Forts sent to England in early 1942... proved that precision bombing by day was practical—and deadly... fought with the R.A.F. 500 miles deep in Fortress Europe despite 40,000 anti-aircraft guns, Focke-Wulf fighters... and sickening losses to the original group.

With 1943 came reinforcements, but the Florent oilfields lost 54 bombers, the two Schweinfurt raids 96. Before the year's end, 60% of the flying personnel were dead, wounded

Noted as missing, prisoners of war. At its peak in Spring 1944, the 8th lost in one frontal week in February 170 bombers, downed 548 German fighters, broke the back of the vaunted Luftwaffe.

In a year of hard, persistent fighting, the 5th battered the German war machine and its industries, shattered Nazi nerves. When D Day came, American armor never met the full strength of the mighty Wehrmacht, but an enemy weakened by

What most Americans fail to realize is that the 8th Air Force saved the lives of hundreds of thousands of doughboys, shortened the European war by perhaps a year . . . earned more decorations and citations than any other military unit in history, as well as our undying gratitude. Watch for the 8th shoulder patch and honor the men who so bravely won it!



MANY of the 8th Air Force and other AAF bombing personnel were schooled in twin-engine training planes powered with engines made by Jacobs... a fact of which we are justly proud... Jacobs Aircraft Engine Company, Pottstown, Pa.



**JACOBS • Pottstown, Pa.**

# Firestone

PRODUCING FOR WAR PREPARING FOR PEACE



## Give Your Customers a BRAKE ...IN YOUR POST-WAR PRIVATE PLANES

YOU HEAR a lot of different opinions about the postwar outlook for the aircraft industry. Some people say that the number of private planes will grow like Jack's beanstalk. Others say that there just aren't enough people with money enough to buy their own planes and who are also able to pass the C.A.A. tests.

But one thing is certain—aircraft manufacturers are planning now to build private planes that are better and cheaper and safer than the prewar models. And one of the big

improvements they are incorporating into their designs are Firestone wheel and hydraulic brake assemblies.

Equipped with Firestone Tires and the Firestone wheel and brake assembly, the safety and kinetic energy capacity, the airplane braking unit on the market today is undependable. It is unsurpassed—under all conditions have failed to produce a brake and it will not freeze in winter or heat and grab in summer.

Would you like full information about Firestone wheel and brake assemblies? A letter, wire or phone call will bring you complete data or a trained Firestone hydraulic Division engineer, without any obligation.

Firestone is made, born in the Firestone Division of The Goodyear Tire & Rubber Company, Akron, Ohio. Firestone is a registered trademark of The Goodyear Tire & Rubber Company.



**FIRESTONE AIRCRAFT COMPANY, AKRON, OHIO • LOS ANGELES, CALIF.**  
TIRES, TUBES, WHEELS, BRAKES, AIR SPRING LANDING GEARS, BATTERIES, SPARK PLUGS, COVERING, FOAMER CUSHIONING, FUEL AND OIL CELLS, RUSHINGS AND MANY OTHERS.

MAKERS OF  
AIRCRAFT SUPPLIES

ESTABLISHED 1900, 1945

## Blackout For Exhaust Flames!



Burning exhaust gases no longer "spot" night-flying planes for enemy observers... thanks to the Solar flame damper which suppresses the tell-tale flames, reduces plane visibility and has greatly increased the effectiveness of night combat operations.

Solar engineers have played a major part in the development of flame dampers because the design and fabrication of products which must withstand high operating temperatures and severe vibrations, possess great structural strength, yet be light in weight, has been Solar's specialized activity for fifteen years.

As the leading manufacturer of airplane exhaust systems and other high temperature alloy products, the elimination of gases, the utilization of waste heat energy, and the control and transfer of heat, Solar has become the recognized authority. Its services are available to aircraft manufacturers with such problems.



SOLAR AIRCRAFT COMPANY • SAN DIEGO 12, CALIF. • DES MOINES 18

AVIATION, February 1946



## Aeroprops for the Planes of Peace

*Reliability and Automatic Operation of this General Motors Propeller add New Ease to Flight*

Pilots in tomorrow's planes will fly with serene confidence, thanks to the brilliant engineering developments of recent years. Important among these developments is the Aeroprop, the war-proved General Motors propeller.

The Aeroprop combines greater lightness with maximum strength—simplicity with utmost reliability. Under powerful hydraulic control, the Aeroprop automati-

cally adjusts its pitch to meet changing flight conditions, moving from low pitch to full feather in only five seconds.

Weight reduction is achieved through use of hollow blades which are steel-ribbed for strength. Simplified design and fewer parts mean reduced wear, quick inspection, and maintenance economy.

These features—each contributing to the reliability of the pro-

pellor—distinguish the thousands of Aeroprops that have helped American planes dominate the skies. These same engineering achievements of General Motors research will serve the millions who will fly in the coming years of peace.



**Aeroprop Advantages**—Lightness for payload... Strength for safety... Simplicity for easy service... Faster Automatic Pitch Change for flight efficiency... Full Feathering for engine protection... Engineered for reliability.



The Lighter, Stronger, More Reliable Propeller

AEROPRODUCTS DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

*Keep them flying—buy another War Bond!*



# A Whole Flock of Advantages



Apex bit holders and "removable" revolutionize the use of Power Bits and Hand Drivers for Phillips Reversed Screws. Look at these advantages:

1. Once you buy the holders you need, you're a flock of owls has only one range of screws for various sized holders.
2. Get your problems on automatic screws on one lot in price.
3. Even between holders and bits, you're a flock of owls on the price because bit and screw prices slip easily and accurately.
4. Range of wood bits for use in driving is necessary. One of course is approximately 10 times as much as the other.

# APEX

THE APEX MACHINE & TOOL COMPANY • DAYTON 2, OHIO



Meet the family of Apex-Phillips Insert Drive Bits



Four sizes— $\frac{1}{8}$ " hex,  $\frac{1}{4}$ " hex,  $\frac{3}{8}$ " hex and  $\frac{1}{2}$ " square comprise the entire range of inserts with these various Phillips sizes for our complete range of bit holders. Send for Bulletin 1012, describing the type of bit and Apex Holders suitably every make of power drive.



If you expect someday to fly your own...

You ought to know about the unique "Propeller with a Brain"

THINK of it! One-fourth shorter takeoff runs! One third higher rate of climb! Cruising faster and farther at the most favorable altitude! All with minimum fuel consumption and engine wear! That's what Aeromatic—the one and only self-acting, variable pitch propeller—means for that postwar plane of yours. And it means long glides for happy landings—with an instantaneous change of pitch for a quick pickup if you overshoot the field.

Completely self-contained and self-acting, the Aeromatic Propeller requires no instruments... no controls... nothing extra for you to watch

or do. Responding to natural forces, it automatically assumes the correct pitch for peak efficiency under all flight conditions. It lets your plane and engine deliver automatically, as no other propeller can, all the performance that is built into them... with safe, simple, economical operation that makes flying real fun.

If you fly, or plan to fly, you will want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder, containing a diagram of the "brain" in an Aeromatic, drop us a line. We'll be glad to hear from you.

The Propeller with a Brain for Tomorrow's Plans



Air Controlled • Electrically Operated

KOPPERS Co., Inc., Bartlett • Hayward Division, Baltimore 3, Md.

Licensed under patents of EVERETT Propeller Corporation

# How are you at Chopping Trees



No, this is no joke. Many businessmen have volunteered to aid the paper shortage by spending vacations from their companies in the timber country, helping out on the man-power problem in the paper pulp industry.

Not that you have the time to do this. Nor that tree-chopping is exactly in your line. But, until the man-power shortage in this vital industry is over, until our armed forces no longer are spread all over the world where food, ammunition and medical supplies must be shipped them in paper protection

wrappers, there is a chopping job you must do. You must chop the use of paper in your business.

Sure, you've done plenty of this in the past month. But right now the need for paper is greater than ever. So the government asks you again to continue paper usage in your firm, see if you can't make even further savings.

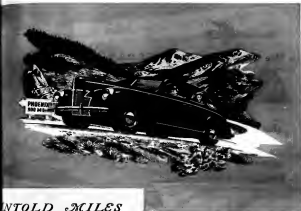
And don't forget that baling wastepaper and sending it to a reprocessing plant is a most important part of the paper conservation job.

*Remember—*  
**PAPER IS  
WAR POWER**



**USE LESS PAPER—SAVE ALL WASTEPAPER**

This advertisement contributed by this publication and prepared by the War Advertising Council in cooperation with the War Relocation Authority and the Office of War Information.



## UNTOLD MILES OF CARBURETOR DEPENDABILITY

Untold millions of miles have been driven on Holley Carburetors. They are known all over the world for their outstanding record of dependability. For almost half a century, Holley research, design and precision production have contributed importantly to engine efficiency, economy and performance. Peacetime motoring will find this same dependable carburetor performance available to all.



**HOLLEY**  
AIRCRAFT, AUTOMOTIVE, MARINE  
CARBURETORS AND ACCESSORIES





In the aircraft of **YESTERDAY**



... the planes of **TODAY**



... the luxury liners  
of **TOMORROW**

**Exide**  
AIRCRAFT  
BATTERIES

FROM the time when storage batteries first became a factor in aircraft design and operation up to the present day, Exides have been the preferred battery for equipment and replacement. This preference is a natural result of a deserved reputation for dependability, long-life and ease of maintenance.

And when tomorrow's liners, cargo carriers and other flying craft are traveling the airways, Exide performance will continue to measure up to aviation's battery needs. For Exide development is keeping steadily in step with the fast pace that aviation engineering has set.

**A LETTER FROM INDIA**  
Increasing letters are frequently received from some of the more than 1400 Exides in the Service. This one comes from India:

"No matter where I go—  
Mojave Desert, North Africa,  
India—Exide Batteries  
still continue to spark me  
in the eye. That's  
not hard to take."

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32  
Exide Batteries of Canada, Limited, Toronto

IN ELECTRONICS "Quality" HAS A SPECIAL MEANING

*Quality*



1. All Amphenol UHF Cable is factory inspected and must bear evidence of test approval before shipment.

Extra significance is attached to the whole idea of Quality when it applies to electronic equipment. High-frequency circuits make special demands of a technical nature that go far beyond the standards of good material and high quality workmanship.

Such requirements are a familiar story to Amphenol, one of the pioneers and leaders in the low-loss transmission equipment field. Amphenol makes the most complete line of both solid dielectric flexible UHF Cables and UHF Connectors and they are now being produced in tremendous volume.

Actually Amphenol's own tests and inspections go beyond required performance and tolerances. Amphenol tests for outstanding quality assure dependable performance under the most difficult of conditions.



Amphenol R.F. Co.  
Cables and Connectors  
are made in America.

## PAY-OFF ON A PURPOSE

Allison's objective for 30 years has been to exact the most work from the fewest ounces of metal. ★ The pay-off on such effort can be appealed in the performance of the 65,000 smooth-running Allison engines powering Army Air Forces planes on every fighting front. It can be seen in the powerful 24-cylinder Allison "3420's". ★ Allison's engineering proficiency in precise workmanship will pay off, too, in the planes of peace—emphasizing those qualities which make your flying enjoyable. And this same precision will endow any Allison product with the ability to serve precisely.

Alison engines powering Army Air Forces planes on every fighting front. It can be seen in the powerful 24-cylinder Allison "3420's". ★ Allison's engineering proficiency in precise workmanship will pay off, too, in the planes of peace—emphasizing those qualities which make your flying enjoyable. And this same precision will endow any Allison product with the ability to serve precisely.

### POWERED BY ALLISON

P-51—Lightning  
P-52—Mustang  
P-40—Warhawk  
A-1H and P-51—Mustang  
P-51—Kingcobra

### LIQUID-COOLED AIRCRAFT ENGINES

**Allison**  
DIVISION OF  
GENERAL MOTORS



KEEP AMERICA STRONG  
BUY MORE WAR BONDS

Every Sunday Afternoon  
GENERAL MOTORS SYMPHONY OF THE AIR—NBC Network



## The Greeks gave us a word for it... now we give it to you

SPERRY first developed its velocity-modulated, ultra-high-frequency tube, the word "KLYSTRON" was registered as the name of the new device.

This name—free from the Greek, as used by scientists of Stanford University—is an apt description of the super-efficiency between spaced electrodes within the tube.

"Klystron" is a good name. So good that it has come into widespread use as the handy way to designate any tube of its general type,

whether a Sperry product or not.

This is perfectly understandable. For the technical description of a Klystron-type tube is unwieldy, whether in written specifications, in conversation, or in instructing members of the Armed Forces in the operation of devices employing such tubes.

These conditions have prompted many requests from standardization agencies—including those of the Army and Navy—for unrestricted use of the name Klystron. In the public interest, Sperry has been glad to

comply with these requests...

From now on, the name KLYSTRON belongs to the public, and may be used by anyone as the designation for velocity-modulated tubes of any manufacture.

Sperry will, of course, continue to make the many types of Klystrons in new products, and to develop new ones.

On request, information about Klystrons will be sent, subject to military restrictions.

**SPERRY GYROSCOPE COMPANY, INC., GREAT NECK, N. Y.**

*Division of the Sperry Corporation*

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TELETYPE • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

AT002, February, 1947

READY  
AND  
WAITING

2044 A.D.

Still young at 99..

It is really worthwhile to use a *permanent* tracing paper, for you never can tell when an old drawing may have to be consulted or reproduced. In many drafting room files there are drawings on ALBANENE that are years old, but are still in perfect condition, and should stay that way for 99 years or more. Protect your designs, your inventions, your business itself—use ALBANENE!

ALBANENE Tracing Paper is treated with Albanite, a crystal-clear, unaltering synthetic developed by the K & E Laboratories. So far as the most severe tests show, it should last almost forever. The paper itself is 100% white tag stock. The Albanite not only makes it ageless but extra transparent. And because ALBANENE stays white, it gives strong, contrasting prints. It's fine to work on too, with pencil or ink—keeps clean and takes erasures well. Comes in rolls, sheets, and pads. Write on your letterhead for sample sheet.

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To Hurt  
Snow From the Runway

Where SNOWGO equipment is used, snow is a minimum of harm from the runways of airports, helping a great part of the costly interruption in flying schedules caused by snowfalls.

During Winter storms, SNOWGOs are as essential to airport runways as the "beacon" to the pilots, the leading lights to traffic control. SNOWGOs keep runways clear—never get in the way of snow to endanger wing tips—never leaves a heavy mass necessitating continuous compression tests or occasional rolling and seeding. There is no packed layer of ice/snow/ruts or snow into rotten danger spots and provide clear path up by wheel paths and fences to wheel tracks or brakes.

Where the field must be completely cleared SNOWGOs are the known method of leading snow. Where compacted snow is provided an "allway field" the easy handling of SNOWGOs ability to stay up "on top" means fine saved SNOWGOs pays for itself when it prevents the first snowfall.

KLAUER MANUFACTURING CO.  
DUBUQUE, IOWA

SNOWGO  
A SNOWGO FOR EVERY SITUATION

**372,444 GALLONS OF FLAMMABLE LIQUIDS  
IN 9 HUGE ROOMS**

## Protected by ONE Cardox Fire Extinguishing System

The five oil processing and storage rooms illustrated here... plus four others and a long pipe tunnel that could not be photographed... represent a major fire hazard in one of America's large war plants. All nine rooms and the pipe tunnel... 941,140 cubic feet... are guarded by a single engineered Cardox Fire Extinguishing System.

Total flooding of any of these rooms with inert carbon dioxide and CO<sub>2</sub> snow is provided by 12 tons of liquid Cardox CO<sub>2</sub> as soon as fire strikes... with substantial reserve for new emergencies.

Here is only one of hundreds of examples of how engineered Cardox Fire Extinguishing Systems utilize fast-acting, non-damaging, inexpensive carbon dioxide to provide enhanced extinguishing performance in protecting large and small hazards.

The enhanced extinguishing performance of carbon dioxide, as controlled and applied in Cardox Systems, is due to these four basic factors: (1) It has unique extinguishing characteristics regardless of plant or atmospheric temperatures; (2) It is available in ample quantity for application at high rate and for total flooding (when necessary) of large areas; (3) It provides high CO<sub>2</sub> "snow" yield for increased cooling effect; (4) It achieves effective protection through relatively great distances—even outdoors.

The hazards in your plant may not be as large as those shown here, but the kind of extinguishing performance that has caused Cardox Systems to be specified for guarding hazards such as these has a place in your fire protection plans. Cardox engineers offer you practical cooperation.



Write for details and Bulletin 325.

**CARDOX CORPORATION**  
MILL BUILDING • CHICAGO 3, ILLINOIS

New York • Boston • Washington • Detroit • Cleveland  
Atlanta • Pittsburgh • San Francisco • Los Angeles • Seattle



*All of the areas illustrated here represent Class B hazards... involving volatile and flammable liquids. Total flooding with Cardox CO<sub>2</sub> is applied at the highest practical concentration in the minimum length of time. An adequate supply of liquid carbon dioxide to cover all of the hazards illustrated is maintained in a single refrigerated Cardox Storage Unit similar to one pictured at left.*

**CARDOX**  
CO<sub>2</sub> FIRE EXTINGUISHING SYSTEMS



The B-29 Altitude in Flight  
Applying Prestite Glass Sealer to  
the B-29 Superfortress



Applying Prestite Synthetic Glass  
Sealer to Windshield of Bell P-43.  
Photo, Courtesy Bell Aircraft Corp.

They cover all and water tightness to the interior of both the Bell P-43 and the Bell P-43 Kingfisher, Private No. 11544 Cals and Prestite No. 24323 Synthetic Glass Sealer. The die. Large quantities of these and other Prestite Sealing Compounds are also used in the construction of the Bell-built, Boeing-designed, B-29 Superfortress.

Thus another famous aircraft builder joins the many who rely on Prestite sealing compounds for many vital uses which include the sealing of fuselage seams, gun turrets, fuel tanks, airplane floats, etc.

To industry at large, Prestite offers the same engineering skills and technical knowledge that led to the development and manufacture of such compounds in those mentioned above. Thoroughly proven in both war and peace, Prestite Sealing Compounds are the result of highly specialized experience in the whole sealing field.

Whatever your own sealing problem may be, or your need for coatings and adhesives, call on Prestite's knowledge. We'll gladly work with you right now on any sealing requirement.

**PRESTITE**

*The Sealing Compound*

**PRESTITE ENGINEERING COMPANY, INC., 2516 Chagrin Avenue, Cleveland 16, Ohio**

**A Partial List of Industries for Which Prestite has successfully Developed Special Sealing Compounds:**

**For the Aircraft Industry:**  
Sealers for  
Internal Fuel Tanks  
Fuselage Seams  
Drip-off, Expendable  
Fuel Tanks  
Gun Turrets  
Synthetic Glass

**Automotive Industries:**  
Air Turbines  
Engine Seals  
Engine Floors

**For the Building Industry:**  
Sealers for Dampness  
and Commercial Water  
Sealers  
Roofing and Sealing  
Low Temperature Insulation in Refrigerated Rooms

**For the Railroad Industry:**  
Sealers for Insulating  
Soundproofing and  
Weatherproofing of  
Railway Cars—Sealing  
Car Windows and  
Open Window Seams

**For the Building Industry:**  
Roof Coatings, Caulking,  
and Waterproofing  
Compounds

**For the Marine Industry:**  
Sealers for rubber joints  
and seams, and waterproofing  
— many non-  
corrosive applications

**For the Automotive Industry:**  
Special Adhesives and  
Sealers

**For the Construction Industry:**  
Sealers for Sealing  
Basement Floors  
Sealers for Waterproofing  
Excavation Work

**For the Marine Industry:**  
Sealers for rubber joints  
and seams, and waterproofing  
— many non-  
corrosive applications



## Maker of Air History— The Boeing Superfortress

Photo Courtesy Boeing Aircraft Company

**Belden ANJC-36 Spark Plug Wire**

**Belden ANJC-40 Shielded Engine Lightening Wire**

**Belden ANJC-48 Triple-Insulated Power Cable**



During engine assembly a wiring harness.  
Belden wire is used in this operation.

## — AND HERE'S ANOTHER PLACE WHERE BELDEN WIRE GOES TO WAR

The Boeing Superfortress, heavily armed and armed with formidable gunpower, serves pilots of the 80th Air Force as a vital weapon of attack. Powered by four huge engines and with a tremendous range, it figures prominently in recent series of bombings of Japan.

Service under battle conditions has rated the Superfortress an achievement for its makers. Into it the Boeing Aircraft Company put the skill of its engineers, the craftsmanship of its employees, and the dependability of proven-tested materials. The Boeing Superfortress is another place where Belden wire goes to war.

Belden wire meets each strenuous requirement with plus values built into it through years of testing, experimenting, and collaboration with aerial engineers. Careful production has given it the qualities to meet aviation's critical needs. Belden Manufacturing Company, 6605 W. Van Nuys St., Chicago 44, Illinois.

# Belden *aircraft* WIRE



Awarded the U.S. Treasury Special Certificate of merit for  
Initiating the War Bond—War Cash National Plan

**Starter, Lighting, and Instrument Cables — SPARK PLUG WIRES**

# COMPRESSED AIR...Speeds Aircraft Maintenance

Air tools play a big part in keeping aircraft "flightworthy."

Air tools are lighter in weight and easier to handle than other power tools of equal capacity.\* Air tools can be started and stopped instantly. Torque and speed can be varied throughout the capacity range—full power is available at the squeeze of the throttle.

Your operators can do an easier, quicker and better job with air tools. The I-R line includes drills, riveters, grinders, wrenches, and many other labor-saving air tools.

For your compressed air supply you can choose from the wide range of I-R stationary and portable compressors. There is a size and type to fit every application.

Let the nearest Ingersoll-Rand engineer give you the facts.

## Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.  
Branches in all principal cities

Photos courtesy Pan American World Airways System B-612



Single-stage, Type ES heavy-duty compressor which supplies air for many uses at the PAA Airport in Mexico City.

View of the modern airport of the Pan American Airways System in Mexico. Inset shows one of the famous Clippers.



This lightweight drill speeds repairs on the tail section of a transport plane in the PAA hangar at Miami.



View of the modern airport of the Pan American Airways System in Mexico. Inset shows one of the famous Clippers.

## How Orco can help You

### DEVELOP NEW PARTS

Where component units of new products may require a combination of properties in a single material, ORCO can help you explore the possibilities of rubber and synthetic rubbers.

### DETERMINE BEST SYNTHETIC RUBBER FOR SPECIFIC NEEDS

ORCO offers you an impartial source of information regarding the comparative advantages of all commercially available synthetic rubbers as applied to any stated specification.

### DESIGN EFFICIENT MOLDS AND DIES

When required, ORCO offers complete service in the engineering of molds and dies to meet your specifications for mechanical molded or extruded rubber and synthetic rubber parts.

### OBTAIN IMPROVED WEARING QUALITIES

If you seek improved resistance of rubber and synthetic rubber parts to conditions causing excessive wear, ORCO may help you by developing an improved compound.

### CONDUCT LABORATORY AND FIELD TESTS

ORCO research facilities comprise modern laboratory equipment and an experienced technical staff available for complete co-operation "from test hole to field test."

### ENGINEER SPECIAL TOOLS AND EQUIPMENT

If your requirements call for special tools and equipment for efficient, large-scale production, ORCO maintains a specialized engineering service.

### CONTROL VIBRATION

Elimination or reduction of vibration, shock, and noise in moving parts of machinery involves problems on which ORCO is prepared to co-operate on every phase of vibration isolation.

### SOLVE PROBLEMS OF BONDING RUBBER TO OTHER MATERIALS

Adhesion processes for bonding rubber and synthetic rubber to metals and a wide variety of other materials are highly specialized services available to you at The Ohio Rubber Company (ORCO).

### REDUCES COSTS THRU IMPROVED METHODS

Unusual "flexibility" of ORCO production facilities assures improved methods to minimize costs on both small or large volume requirements on either intermittent or continuous runs.

IN ONE WORD, WE OFFER YOU

# "ORCO-OPERATION"

The Ohio Rubber Company - Willoughby, Ohio

BRANCHES - DETROIT - NEW YORK - CHICAGO - INDIANAPOLIS - WASHINGTON - CLEVELAND

STATION, February, 1946

Rough sliding  
means  
trouble!



**Exclusive Crown Zipper tooth construction assures quick, smooth, effortless sliding, even around sharp curves!**

Look at a Crown Zipper closely, and what do you see? Each individual tooth is identical on both sides!

This exclusive Crown design permits the sliders on Crown Zippers to move with perfect freedom in both directions along the zipper track.

Even on heavy aircraft and truck-tractor covers, Crown Zippers operate quickly, smoothly, almost effortlessly—take sharpest curves without sticking or bunching the fabric.

This big, basic Crown Zipper advantage is but one of many Crown innovations that will make for better service in postwar aircraft equipment applications.

Actually, Crown engineers, working in the field with our armed forces, have developed far advanced

covers over old-style, conventional zippers. (See complete list of Crown Zipper specialties below.)

When you turn to postwar, Crown's great backlog of experience in improving zipper design and in adapting zippers to meet special jobs will be invaluable. For our designers will sit down with your own designers to adapt—or, if necessary, create a special zipper application to meet your individual manufacturing needs.



ONLY CROWN ZIPPER TEETH ARE IDENTICAL ON BOTH SIDES, TO INSURE SMOOTH SLIDING

**CROWN  
ZIPPERS**

are 5 ways better



Member of the J. & P. Coats - Clark's Family

THE SPOOL COTTON COMPANY • 745 Fifth Avenue, New York, N. Y. (Crown Fastener Division)

W. A. PATTERSON, President of United Air Lines



**"...YOU SAY VIBRATOR POWER SUPPLIES CAN INCREASE SAFETY AND COMFORT IN PLANES?"**

W. A. PATTERSON, President of United Air Lines, recently said—

"It is our belief that the war has advanced public acceptance of the airplane as a mode of transportation by its years. The airlines, like every other service industry in the public, must anticipate their passengers' expectations of new facilities for greater comfort and safety. United will put in service now, large size passenger airplanes offering comfort, convenience and thoughtful amenities including sleeping berths, and flying from coast to coast in less than an hour with one descent to secure safe flight."

Only right now with Vibrator Power Supplies to bring passengers the greater comfort of fluorescent lighting as well as the convenience and safety of radio and intercoms, U. S. Black Light equipment is available in a safety device for emergency power illumination in flight to eliminate blinding interior glare and to give fast, direct defauld emergency illumination. Engineered to specific space-saving requirements, Electronic Laboratories products are used wherever space must be changed in package, frequency or type. U. S. engineers reserve inquiries.

#### THE X-244 LIGHT

Black Light illumination at regular intervals is a new cabin phase. The X-244 Light provides both ultra-violet (black) and visible light and white light. No Control Ring offers easy selection of desired intensity and type of light. Operates on 20 volts and weighs 18 ounces. Includes instructions for installation and use. Quickly adaptable for use in emergency cockpit lights.



For more information on Black Light

**Electronic LABORATORIES, INC.**

DESIGNS TO BE EMPLOYED FOR SHORTER COMMUNICATIONS, AND ELECTRIC MOTOR OPERATION • ELECTRIC, ELECTRONIC AND OTHER EQUIPMENT



# "AND I SEE *"Spring-life"* BELLOWS IN THOUSANDS OF NEW POST-WAR APPLICATIONS"

Thanks, Swami, but we know that we have already heard from thousands of engineers and designers who want to know more about the 7 advantages of Cook "Spring-life" Bellows. Engineers and designers who realize that "the best equipment needs the best components," but what we want is the names of the men who do know the full story of "Spring-life" bellows and how they go beyond the scope of ordinary bellows applications.

We know that "Spring-life" bellows construction has opened a wider field for post-war bellows applications. We know that other "Spring-life" bellows have made their final contribution to the winning of the war, they will be incorporated in some of the finest post-war equipment because, despite the longest war-time back-log of material, our engineers are still managing to cooperate with other manufacturers in the designing of numerous future projects.

**WHAT WE DON'T KNOW** are the names of all the engineers and designers who, we feel sure, will be glad to have the complete, full story on "Spring-life," showing characteristics, construction data charts, etc. Because clarity can't help us with the problem, why don't you send for your copy of this 44-page book which may help you solve many vexatious engineering problems.

Remember one of our field engineers will be pleased to call on you and confer with you on your present or post-war problems. Although supplying our armed forces with all their demands, at the same time, it is still our primary job, our engineering force is efficiently geared to assist you with your future considerations.



2700 SOUTHPORT AVENUE - CHICAGO 14, ILL.

## THE 7 ADVANTAGES OF "SPRING-LIFE" BELLOWS CONSTRUCTION

1. **CHOICE OF METAL**
2. **UNLIMITED GAGING DIMENSIONS AND LENGTHS**—Cook "Spring-life" construction gives an almost unlimited variety of lengths of bellows.
3. **WIDE RANGE OF SUSCEPTIBILITY**—Flexibility varies directly with the number of turns and type and thickness of metal used.
4. **SAFETY**—Cook "Spring-life" bellows are particularly suitable for applications requiring extreme accuracy and strength, as well as non-leakage. "Spring-life" bellows are built to resist an extreme amount of pressure, and with extreme burst strength.
5. **UNIFORM MOVEMENT**—Because Cook bellows are made of uniform materials, they maintain a uniform movement at all times, and without undue strain to the connected parts.
6. **CONCRETE USE**—Exposure to heat has proven that Cook "Spring-life" bellows can take in, gas and liquid and are suitable for use in all kinds of industrial applications.
7. **BESTER ADAPTABILITY**—Because of the above advantages, Cook bellows open a wider field of bellows applications, including high temperatures, pressure, corrosive liquids, vacuum, extreme conditions, sanitary and electric spring use.

## SHORT RUNS and LONG RUNS

Specializing in the manufacture of pipe, tube and hose fittings, for American and Allied fighting machines, Masters has accumulated equipment and staff of outstanding versatility.

A great variety of parts in aluminum, brass, steel and other materials are milled, drilled, turned and threaded in our plant. Short runs and long runs of parts and

accessories, ranging from photographic to railway, aircraft and marine equipment, fall right into the groove at Masters.

Skill, complete gaging, inspection equipment, and adequate engineering combine with economical manufacturing "know-how" to make Masters a good bet for your present and postwar manufacturing. Let our engineers help you.

"Quality Control—Rejections Consistently Less than 1/10 of 1%"



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*America's Most Versatile Fitting Factory*





## INSUROL HAS LOW MOISTURE ABSORPTION

The dangers of damage from moisture and corrosion are minimized when INSUROL is used. And, in addition, it has the ability to absorb shock and to stand up under rough handling.

It is not strange, therefore, that both Molded and Laminated INSUROL are being widely used in war products—are being specified for use in many types of products for tomorrow.

There are many grades and types

of Laminated and Molded INSUROL, with a wide range of chemical, electrical and mechanical characteristics. One or more types of INSUROL will meet practically every requirement.

Richardson Plastics have had years of experience in working with designers and manufacturers. They will be glad to help you determine the grade best suited to your needs. Write for complete engineering information today.



Every day parts and products made of Laminated or Molded INSUROL are successfully meeting all kinds of weather and temperature conditions. Be sure to get the facts about this and other plastic products which are standing UP TO IT. It is specified for use in many types of products.

# INSUROL

Precision Plastics

The RICHARDSON COMPANY



A Mark of Quality  
that Your Customers  
Will Appreciate

Color coding will play a big part in civilian plane identification. The use of Berryloid Aircraft Finishes will give you an important advantage in achieving identification, distinction and customer preference for your future plane.

Millions of gallons of Berryloid primers, pigmented dyes and camouflage materials have been used on American and Canadian war planes. Fighter pilots and civilian technicians in every war theater know the uniformly high quality and durability of Berryloid Aircraft Finishes. Their familiarity with these well-known finishes

will continue to be a big influence in their postwar aviation purchases or recommendations.

Everybody knows and accepts Berryloid as one of the "leader products" in the aviation industry. It has held this position of leadership for more than 30 years. Include Berryloid Finishes as a quality feature in your new postwar plane. It will give you a definite competitive advantage.

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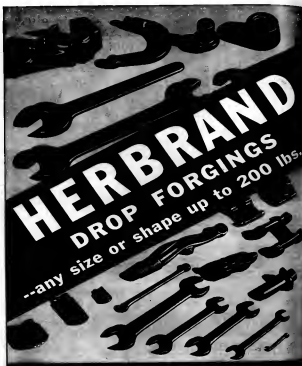
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AVIATION, February, 1943



# HERBRAND

## DROP FORGINGS

--any size or shape up to 200 lbs.

THE HERBRAND CORPORATION • Fremont, Ohio  
Drop-Forged Tools Since 1881

### HERE'S HOW RIVNUT WORKS



1 Thread rivet into "pull-up" end and head of Rivnut makes work of head.

## NEW RIVNUT MAKES TOUGH FASTENING PROBLEMS EASY!

Used as Blind Rivet . . . as Nut Plate for attachment . . . or both at once!



RIVNUT is a one-piece tubular rivet, countersunk and internally threaded. It is upset with an easily operated hand tool working entirely from one side. A circumferential bulge forms on the blind side that is large enough to prevent its being pulled through metal as plastic even under conditions of eccentric load.

For either use—as a blind rivet or as a nut plate for attachment—Rivnut has important advantages. One-piece design keeps cost low—makes installation so easy, even a blind man can do it. Rivnuts are light, strong, compact—ready for use as received. They are as normally wide bearing surface, yet require a smaller hole as other blind fasteners. Keyed Rivnuts are available for use as nut plates.

Rivnuts are now made of both corrosion-resistant aluminum and brass. In addition, a new *plated Rivnut* is available for use in wood or plastics. If special-purpose Rivnuts are needed for any particular application, our engineers will be glad to work up special designs for you. The B. F. Goodrich Company, Dept. 103, Akron, Ohio.



FREE . . . NEW "RIVNUT DATA" BOOKLET

Get the whole story—the story of Rivnut fasteners—from the Rivnut Company. Write for your free copy today. Send this ad to B. F. Goodrich Company, Department 103, Akron, Ohio.



2

Insert Rivnut into hole. When Rivnut with force is used, the hole is pulled in to make the Rivnut permanently set in place.

3

Turn Rivnut to right angle to work, remove force. Rivnut "pulls" and sets head, which makes circumferential position in hole, resulting in head against the blind side.

4

Remove "pull-up" end, leaving Rivnut in place. Rivnut is now ready for use in a nut plate.

5

Insert Rivnut into hole, remove force. Rivnut "pulls" and sets head, which makes circumferential position in hole, resulting in head against the blind side.

**B.F. Goodrich**  
**RIVNUT**

IT'S A RIVET. IT'S A NUT PLATE

# This Versatile MICRO SWITCH HOUSING Meets Widest Range of Aircraft Uses

The Type "H" Micro Switch Housing has incorporated the ideas of leading aircraft engineers and accurately meets widely varying airplane requirements.

This aluminum die-cast housing is designed to operate with the Type "R31" Micro Switch and provides a wide selection of actuator plunger, contact construction and mounting accommodations. The housings are supplied in both right and left, with or without ground connection.

The large illustration shows an open view of the Type "H" housing with 5/8" overtravel plunger and mounting ears. These are available with straight or adjustable angle contact fittings with 1/2"-20 or 3/16"-24 A-N threads, or 3/16" hole for open wiring. Overall size is 1" thick, 3 3/4" high, 3/4" wide. Weight, without switch, is .237 pounds. The smaller illustration shows a right hand Type "H" aluminum die-cast housing provided with a sealed 3/8" overtravel plunger and angle contact fitting. Overall size of this housing is 1" thick, 1 1/2" high, 3/4" wide. The actuator, without Micro Switch, is .272 pounds.

These are but two examples of the wide range of different ways in which these aluminum die-cast Micro Switch housings can be secured to fit many aircraft requirements. They afford mechanical protection, contact connection, sealing and radio shielding as conditions may require.

For complete details on other types of metal die housings and actuators for the use of Micro Switches in aircraft, send for our Catalog No. 75.

**CHARACTERISTICS OF TYPE "R31" AIRCRAFT MICRO SWITCH**  
The Type "R31" Micro Switch uses the three-bladed, beryllium copper spring construction which has proven its excellence in the industry of Micro Switches used throughout the aircraft industry.

The Type "R31" Micro Switch incorporates contact separation of .017" which satisfactorily compensates highly unfavorable loads under conditions of extreme altitude.

Micro Switch Corporation, Freeport, Illinois  
Branches: 40 E. Ohio St., Chicago (11) • 4002 Euclid Ave., Cleveland (1) • 11 Park St., New York City (1) • 1200 W. 8th St., San Antonio (1) • 1000 N. 10th St., Dallas (1) • 1000 N. 10th St., Portland, Ore. • Boston, Tex.

LET'S ALL BACK THE ATTACK... BUY EXTRA WAR BONDS



# MICRO ME SWITCH

Micro Switch Corporation Freeport, Illinois U.S.A.



Type "H" Housing showing easy access to Micro Switch.

## FEATURES OF THE TYPE "H" MICRO SWITCH HOUSING

1. Built alone Switch Units are easily replaced, since they are carried on a job of economy fitting pin.
2. Entire assembly may be sealed against any of water, dirt, oil, etc., by means of a synthetic rubber seal placed on the plunger. See literature.
3. Quietest and smoothest action secured with flat leaf action closed screws.
4. A ground connection from the switch to the pin may be provided inside of the case, built wiring space is provided.
5. Housings and actuators become parts of the plunger and require no disassembly. Not are built for ready field replacement.

# Cylinder life multiplied by 5



Cylinder life that is multiplied by 5 is the experience of a large city bus company who made the comparison between PORUS-KROME cylinders and ordinary cylinders in the same engines.

The reason that cylinders last longer when they have been treated with PORUS-KROME, applied by the Van der Horst process, is that it resists wear and corrosion better than any other known cylinder material.

PORUS-KROME is pure, hard chromium which has been processed so that there are myriads of tiny pores and channels in its sur-

face. These pores and channels serve as reservoirs which hold lubricating oil and feed it back to the cylinder surface as needed. Better lubrication, plus the fact that chromium is so much harder than iron or steel, reduces wear to a minimum. Field tests have shown that PORUS-KROME multiplies cylinder life from four to twenty times... depending on the size and type of engine.

If you are a builder or a user of engines... gasoline or Diesel... you will profit by specifying PORUS-KROME. Write for complete information today.

# PORUS - KROME

Good for the Life of your Engines



VAN DER HORST CORPORATION OF AMERICA

CLEVELAND 11 • OHIO

WANTON, February, 1943

# The Truck With a \$50,000,000.00 ENDORSEMENT

FWD's MODEL HAR



A truly great truck — the FWD Model HAR — a truck that in just four years has won the endorsement of motor truck users to a total of \$50,000,000 in purchases of this single model — a truck that has achieved the phenomenal record of \$50,000,000 in manufacturing experience in the comparatively brief span of 46 months.

Rated at 30,000 lbs. gross, the Model HAR embodies the highest development of the four-wheel-drive principle, pioneered and sponsored by FWD since 1910. Truck operators know that the true

four-wheel-drive principle as applied in FWD's gives these trucks a basic mechanical advantage — qualifies them to get through regardless of road or weather — to go with greater safety — to perform year after year at lowest cost per ton mile — to conserve our precious gas-oil-tires-replacements. When the call is for rugged, dependable trucks to provide vitally important motor transport, your confidence is well placed in FWD's.

THE FOUR WHEEL DRIVE AUTO CO.

Chicopee, Massachusetts

Charles F. Parker, SEYMOUR, IND.



## Humidity Conquered

DC  
DOW CORNING  
VARNISHES



### HIGH TEMPERATURE SILICONE INSULATION

Humidity, the primary reason for failure of motors and other electrical equipment, is conquered by DC Silicone Varnishes. Even under extreme conditions of condensation, severe overloads or idleness in moist locations, DC varnished equipment starts and runs at full load.

High temperature silicone insulation was first made possible by DC Varnishes. These new heat stable resins are natural complements to the inorganic spacing materials—mica, Fiberglass and asbestos. Dow Corning Silicone Varnishes provide bonding and filling dielectrics which are highly resistant to heat, moisture, oil and chemicals.

DOW CORNING CORPORATION  
BOX 592, MIDLAND, MICHIGAN

ATTENTION, February, 1945

DOW CORNING 933 . . . available in commercial quantities, is a heat curing, high temperature stable silicone varnish for impregnating motor stators, transformer coils and other electrical equipment; for varnishing Fiberglass or asbestos covered wire; for varnishing Fiberglass and asbestos electrical insulating cloths, tapes, tying cords and sleeving; for bonding Fiberglass and metal combinations.

DC

**Unequalled for  
compactness  
and efficiency**

# **SIoux** AIRCRAFT wet valve seat GRINDING MACHINE FOR INLINE AND RADIAL MOTORS

STANDARD THE



WORLD OVER

Precisioned by SIoux for both IN-LINE and RADIAL Aircraft motor work, this complete unit enables the operator to speed up with precision in either production or maintenance.

Everything within easy reach. It wet grinds both exhaust and intake valve seats without removing cylinders. Wheel loading and scratching is eliminated and wheel dressing is reduced to a minimum.

Write at once for full details.

## What will an Ex-Pilot expect of a **PEACETIME STEERING WHEEL?**

Certainly no less than the qualities and serviceability of the finest Lumarith® Plastics for war planes.



Looking ahead to easier care and pleasure of tomorrow? Give a thought to that you get handled most—the steering wheel. Plastic comes to mind first of course—probably Lumarith, because this versatile Celanese plastic has been so thoroughly proven in war and peace.



### ON THE ONE HAND

Dimensional and Surface Stability—Lumarith injection molded steel metal. Unusually tough even at temperature extremes; highly resistant to moisture, aging, warping. Elongation, no impor-

tant, is more than adequate to handle differences in expansion coefficients between plastic and metal cases. The chip-proof surface actually is self-polishing. Colors are rich, stable.



### AND ON THE OTHER

Lightness and "Feel"—Formulations of Lumarith C A, Lumarith X, and Lumarith E C are lightweight without sacrifice of flexural strength. Molded parts

are lasting in the sun despite the weather.

Plastics will be bigger than ever in post-war automotive production. Let us help you plan projected improvements. We have accumulated data on a wide range of Lumarith formulations for all types and grades of automotive plastic applications from steering wheels to dash crystals. Celanese Plastics Corporation, The First Name in Plastics, a Division of the Celanese Corporation of America, 180 Madison Avenue, New York 16, N.Y. R-10, Inc.



The first Stinson plane—the first plane to combine a closed cabin, brakes on wheels, electric starter, and inherent stability

## Stinson "firsts" before, during, and after

THE NAME "STINSON" has been associated with personal plane aviation leadership ever since that name was first given to an airplane, back in 1926.

When this 1926 Stinson took to the air, it carried with it an impressive number of "firsts."

### DESIGN "FIRSTS"

Stinson was the first plane to combine the following features:

- An enclosed cabin
- The safety afforded by brakes on landing wheels
- The convenience of an electric starter
- The comfort of a cabin heater

### PREWAR PERFORMANCE "FIRSTS"

During the past 19 years Stinson has piled up an impressive number of performance "firsts" in the fields of commercial and personal flying:

- A Stinson plane carried the first air mail in China
- It carried the first government mail in Mexico and in the Philippines
- Made the first flight from Detroit to Tokyo, and from New York to Ba.
- Inaugurated the world's first air-mail pick-up service
- First explored the Greenland route to Europe, the present-day route of the North Atlantic Air Ferry.

"Out in front" of the front, these sturdy little Stinson "Flying Jeeps" are serving as the "eyes" of the armed forces, as flying ambulances, and on important liaison duty.

The Stinson Voyager is the No. 1 plane of the Civil Air Patrol. It has the distinction of carrying out 65 per cent of the Patrol's wartime operations, which

have included the sinking of a number of submarines and the saving of hundreds of lives.

The Stinson Reliant AT-19 has been widely used as a navigational trainer by the British. And almost every airline in the United States uses Stinson planes to train and check their pilots.

### THE STINSON VOYAGER 125...

the No. 1 Plane for Postwar Personal Flying

The first postwar personal plane designed by Stinson—the Voyager 125—combines the safety and reliability of the prewar Voyagers with the toughness and utility of the Stinson "Flying Jeep."

Here are some of the high lights of this quality personal plane—

Carries three passengers in addition to pilot.	345-hp. take-off run 285-ft. landing roll—with flaps down.
Maximum speed of 123 m.p.h. at sea level.	Powered by 125 h.p. engine.
Range of 670 miles without refueling.	Cruising speed of 112 m.p.h. at 55 per cent power.
Service ceiling 14,000 ft.	Rate of climb—750 ft. per minute at sea level.

**Parts for Stinson Planes.** We are now making a full line of parts for the thousands of Stinson planes now in service. Order spare parts for your Stinson from your local Stinson distributor or direct from the factory.



The Stinson "Flying Jeep"—wartime success in the personal flying—has demonstrated its sturdiness and ability as the No. 1 Stinson plane of the Army, Navy and Marine Corps all over the world.



Stinson "Flying Jeeps" serve the armed forces as flying ambulances, observation and liaison planes, under the toughest flying conditions.

### STINSON "FIRSTS" DURING THE WAR

Stinson's main wartime job has been the manufacture of liaison and training planes for our fighting forces—the Stinson Sentinel, or "Flying Jeep," the Stinson Vigilant L-1, and the Stinson Reliant AT-19.

A Stinson Sentinel, hopping from the deck of a carrier, was the first American plane to land on Japanese-infested Pacific Island, while U. S. Marines were slugging it out for the beachhead... only one typical instance of many similar occurrences when Stinson planes took part in invasions.

# Stinson

The Aircraft Standard of the World

Division of Consolidated Fictive Aircraft Corporation, Wayne, Michigan



The Stinson Voyager 125 is the forerunner of a distinguished line of planes for personal flying. They are Stinson's most modern and most useful planes. Write to Preliminary Sales Department, Stinson Division, Consolidated Fictive Aircraft Corporation, Wayne, Michigan.

CLEAR OUT THE

# "Fastening Bugs"

BEFORE YOU SET UP  
FOR PEACETIME PRODUCTS



## Specify the SHORT CUT FASTENING METHOD and avoid later changes, expense, delays

Don't wait until you resume manufacture of your peacetime product to find out that needless tapping, needless inserts in plastics, or other fastening "bugs" are slowing down assemblies and running up your costs.

Check up now, while your plans are still in process. Choose fastenings as carefully as you settle any other factor of design. Make sure you are using the short cut fastening method—Parker-Kalon Self-tapping Screws—wherever possible.

Give your product the advantage of the 30% to 50% saving in assembly time and labor made possible by P-K Self-tapping Screws. Eliminate tapping for machine screws and tap expense—frustrating with nuts and bolts—costly inserts in plastics—riveting in hard-to-reach places.

USER'S GUIDE—FREE! P-K "User's Guide" describes all types of Parker-Kalon Self-tapping Screws and tells where to use them. Designers and assembly planners need this important information. Write for a copy.

### ASK THIS EXPERT ON FASTENINGS

how you can make your product assembly simpler and stronger, how you can save time and lower cost. The P-K Assembly Engineer gives selected advice, because P-K makes all types of Self-tapping Screws. He'll call at your request or, mail assembly details for recommendations. Parker-Kalon Corporation, 390 Varick Street, New York 14, N. Y.



**PARKER-KALON**  
Quality-Controlled  
SELF-TAPPING SCREWS



Will needless tapping and faulty "line-up" slow your assembly?

Here's how Pyrene planned ahead and liked these "bugs"

This well-known maker of foodlighting equipment, checked fastenings carefully when designing the Fluorite extinguisher. Two fastenings were needed to attach a nut cap to a steel angle tube permanently, and P-K Type "U" Screws were chosen for three reasons...

1. If machine screws were used, tapping would take extra time, and tap breakage would be high because the holes do not always line up exactly. This would also create difficulty in driving machine screws. Type "U" Screws, however, can be driven into plain drilled holes.
2. A tamper-proof fastening is desired, one that discourages disassembly. P-K Type "U" Screws made this certain.
3. Because of their simplicity, P-K Screws proved the speediest fastening method, and provided complete security as well.

For more Speed in the "Tight Spots"



(Photo courtesy Republic Industrial Corporation)

## —Use Flexible, Versatile Snap-on "Combinations"

Remember back when "tight spots" were roundly damned as "bad design". Today they are the accepted penalty of good design... the unavoidable result of packing incredibly high performance into shorply restricted dimensions.

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Snap-on nation-wide service, with 38 factory branches in key production centers, provides right-at-hand personal tool service to industry everywhere. Write for Snap-on catalog and address of nearest branch.

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*Special*

# NOW EACH IS PART OF OUR LINE OF AIRCRAFT SWITCHES

We will be glad to send information on these and other switches in our complete line. Blueprints are also available. If you have a switch problem remember that the switch here at one time represented what was a switch problem to somebody else.

## TECHNICAL DATA IN BRIEF

### All Switches Altitude, Heat and Cold Tested

- +\*\*1. JWBSC—Single hole mounting. Overall length 1" diameter .96".
- +\*\*2. DSD—Large flange type mounted from front of panel.
- +\*\*3. DSD—Large flange type with thread mounting.
- +\*\*4. DSD—Small flange type with thread mounting.
- +\*\*5. DSD—Small flange type with thread mounting.
- +\*\*6. DSD—Small flange type with thread mounting.
- +\*\*7. DSD—Small flange type with thread mounting.
- +\*\*8. DSD—Small flange type with thread mounting.
- +\*\*9. DSD—Small flange type with thread mounting.
- +\*\*10. DSD—Small flange type with thread mounting.
- +\*\*11. DSD—Small flange type with thread mounting.
- +\*\*12. DSD—Small flange type with thread mounting.
- +\*\*13. DSD—Small flange type with thread mounting.
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Note that ball-type plungers can be furnished in two lengths.  
+\*\*21/22—15 ampere, 30 volts of 50,000' altitude.  
All ratings R.C., Inductive Load.  
+ Can be furnished normally open, closed, 2 double or single pole double throw.

All switches double break—heavy silver contacts

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ENTREPRENEUR February, 1945



# The B-29 forecasts a new kind of air travel

**Its AiResearch Pressurized Cabin Controls prove substratosphere flight is safe—and comfortable**

ONLY YESTERDAY the substratosphere was "no-man's land." To travel its thin, freezing air, men had to wear bulky, electrically-heated clothing—oxygen masks.

The Boeing B-29 is changing all that. Pressurized Cabins enable the Superforts to fly 30,000 feet, and higher, with complete safety and comfort for those inside.

AiResearch's part has been the development of air pressure controls . . . devices that keep "high-altitudes" outside the cabin, seal a comfortable "low-altitude" inside the plane at all times.

In peacetime, you will fly in similar AiResearch comfort-protected cabins. They



will help lift commercial flying to faster, smoother, high-up levels. There will be no air pressure changes to cause headaches, dizziness and ear-popping. You'll enjoy warm air or cool, as you like it, in a cabin free of smoke and odor.

Yes, a new kind of air travel is ahead. Count on AiResearch to help create it . . . and to develop new devices for your greater comfort on the ground, as well. AiResearch Manufacturing Co., Los Angeles, Phoenix.



Superfortresses carry AiResearch Cabin Pressure Regulating System  
Engine Oil Cooling Systems • Engine Air Intercosting Systems  
Supercharger Aftercooling Systems • Automatic Fuel Flow Control Systems  
Temperature Control Systems

AVIATION, February, 1945

# HAPPY LANDINGS FOR THE MIGHTY B-29...



Barco Becks Link Assemblies are giving consistently high performance on the Boeing B-29 Superfortresses. Through responsive movement, Barco guards the vital fuel-conveying pipes from vibration and shock, gives fluidity to brake, and retracting mechanism hydraulic

lines. Even the oxygen re-breather system in the turret is protected by Barco. The proven safety value and low maintenance cost of Barco Flexible Joints (winterized for service conditions) have led to their use on many other types of military and commercial aircraft.

Write us about our 3000-point pressure tested joints for aircraft cylinders and other applications.

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AVIATION, February, 1945

## FLEXIBLE JOINTS



"MOVE IN EVERY DIRECTION"

One year is tested  
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and ball joint with  
every motion and  
resistance meas-  
ured through every  
angle.

# HERE'S WHAT YOU CALL A REALLY GOOD IDEA

... and you ought to be able  
to think of one just as good!

THE LAPOINTE SHOCK RING JIMMY came to us without a name. It was merely an idea about how to meet a great need in servicing two popular makes of light planes. From its first crude form, we developed it into a handy, foolproof tool. Today it is in enormous demand.

Now we'd like to turn our engineering and production skills to other servicing problems. You can help us do this ... and earn money for yourself.

## HERE'S ALL YOU HAVE TO DO

Think of some servicing problem like shock ring installation, that should be answered by some new device. Write us a letter, describing the problem. If we can solve it, and put our solution into production, we will send you a \$500 check for telling us about the problem. (Of course, the first person to suggest the problem will be the only one considered on any single matter.)

Better yet, if you yourself have devised, or can devise some method of meeting a servicing problem, let us know what it is. If we decide to develop your idea and put it into production, we will make arrangements with you on either an outright purchase or royalty basis — as we have done with the man who suggested the Jimmy. (He gets a set figure for every Shock Ring Jimmy sold.)

Give complete details, such as the make and model of shop you are writing about. Include rough sketches, if possible. Why not sit down tonight, remembering all the servicing difficulties you've ever experienced, and write us that letter?

**LaPointe**  
ENGINEERING COMPANY  
UNIONVILLE, CONNECTICUT

Manufacturers of Precision Tools and Aircraft Accessories



HOW IT WORKS: The end of LaPointe Jimmy tool, though double duty, does Jimmy's usual work in place, the work or pull handle up and down.



WHAT HAPPENS: Shock ring easily slides down handle and over shock, without any use of forceful. Plug it in, adjust hole, Jimmy goes off, ready for next job.



CLEARER TAYLORMAN: Shock, Oliver shows, does better to use as Plug Co. This device has Jimmy made to quickly and quickly in hand.

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## PUSH BUTTON BRAKES

at the  
*Speed of Sound*

Operated by a push-button on the pilot's control wheel, two 114 hp electric actuating units open "diver brakes" on P-38 wings, to give maximum maneuverability even at speeds approaching that of sound. The flaps do not suddenly slow the plane in lightning-like dives but help control it—to lock the phenomenon called compressibility. The action of the flaps extends the range of safe flying speed with fixed wing surfaces.

Designed from scratch by Electrical Engineering & Mfg. Co., the actuators meet severe unfailing and uniform operation in the space of seconds, and meet stiff weight and size specifications. The units must also fit the wing patch of current P-38's as well as earlier models now in service zones, in either case without requiring major structural modifications.

Also the way, this type of electric motor engineering and design ability may prove invaluable to you. If you have specially tough motor problems, let EEMCO help you solve them.

**DATA:** Disc flap actuating motor, 114 hp, 18,000 rpm—equipped with magnetic clutch and brake—A double integral gear reduction unit operates screw jack actuator—Maximum load, 3,000 pounds, with 2 1/4" travel on jack in less than 2 seconds—A control gear reduction drive system controls for opening and closing specially developed limit travel switches—Frame G250-C.

Send in your restoration today for "Current Build History" for a World of "Hondas" now in preparation. Copies of this limited edition will be distributed only on written request.



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This accurate, uniform heating is simplified into a "push button" job for unskilled help, with all equipment and controls in one safe, space-saving cabinet. The cabinet is shielded to minimize interference with radio communications.

Single standard units are available in output capacities ranging up to 200 kw. The range of frequencies is wide enough for almost every dielectric and induction heating need. For more information, write for Descriptive Data 85-693. Or, for suggestions on a specific application, ask a Westinghouse engineer or call Westinghouse Electric & Manufacturing Co., P.O. Box 100, Pittsburgh 30, Pa. j-6000

**2 KW RADIO-FREQUENCY GENERATOR**

This unit has a nominal output of 2 kw. Controls and meters are all conveniently located on front panel. Circuit breaker and relays are readily accessible through the lower door on left side of cabinet.



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### AIRCO No. 6A OXYGRAPH

The motor-driven Airco No. 6A Oxygraph is designed to provide the speed, flexibility and accuracy essential to low-cost production of flame-cut steel shapes in any quantity.

It quickly cuts steel plate of light and heavy sections to any shape and size. It's the tool for bending, straightening, straight cutting, stock cutting—changing from one job to another in minimum time—using up to eight torches with standard equipment.

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## ALCOA SUGGESTS: STEPPED EXTRUSION

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Stepped extrusions can provide a larger, integral section from which the attachment fitting

is cut out. This avoids the extra weight and cost of a splice.

Will stepped extrusions fit your production? Each case must be analyzed individually from a design and an economic standpoint. Alcoa engineers will gladly give you the benefit of their experience to determine the facts. ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

# ALCOA ALUMINUM





Bond Foundry can afford to make IMPARTIAL, level cost recommendations . . . because Bond builds casters to suit every industrial requirement. There's no need for Bond to recommend a caster that's about right . . . when Bond can always supply a caster that's exactly right.

Bond specialization does it. All casters produced at Bond are for industrial use. Only through such specialization can a manufacturer provide casters in sufficient variety to cover all industrial needs. Write today for free catalog K-34 . . . and see for yourself.

**Bond M.S. Caster.** (Left) Entirely different in design, this roller casters are provided with long service because of the special arrangement of its double ball race and the use of durable Bond roller metal. Pressure indicated throughout.

**Bond Dual Wheel Caster.** (Below) Casters of this design are used widely in both wheel and roller casters. They are long life, heavy duty, roller ball race casters. Pressure indicated throughout.

**Bond Self-Steering Wheel Caster.** (Below) Bond casters of this design are used widely in both wheel and roller casters. They are long life, heavy duty, roller ball race casters. Pressure indicated throughout.

**Bond Self-Steering Wheel Caster.** (Below) Bond casters of this design are used widely in both wheel and roller casters. They are long life, heavy duty, roller ball race casters. Pressure indicated throughout.

BOND FOUNDRY & MACHINE COMPANY, MANHEIM, PA.



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**Rely on These Bond Reliables**  
TO HELP SPEED UP YOUR PRODUCTION PROGRAM



**Bond 100-A Caster (right).** The preferred light-weight caster. Size from 4" to 12" with capacities up to 400 lbs. per caster. Heavy all steel construction. Casters are available in various sizes and capacities. Casters are available in various sizes and capacities. Casters are available in various sizes and capacities.

**Bond 100-A Caster (left).** The preferred light-weight caster. Size from 4" to 12" with capacities up to 400 lbs. per caster. Heavy all steel construction. Casters are available in various sizes and capacities. Casters are available in various sizes and capacities. Casters are available in various sizes and capacities.



## "The Sky Really Is the Limit!"

says T. E. BRANIFF, President, Braniff Airways

NOT MANY YEARS AGO, man was painfully limited by the natural barriers of his world, by mountains, seas, and the air. Now the great American planes which carry us of supplies across these barriers have reduced them to problems on a map; but the natural barriers remain.

"Let us overcome these natural barriers as we have overcome the natural barriers and, 'The sky really is the limit' to aviation's ability to expand our pioneer trade.

Aviation's plane for the future range all the way from open airfields to packaged airports. But none of these plans will be translated into flight-hours or airfields or trade routes—until it is properly sold! And perhaps the first place for aviation to talk up its ideas is the "best place" market of U. S. citizens who are always ready to buy progress whenever they see it in business or in private living.

Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here gives them wider circulation in the name of

AVIATION'S  
SILENT  
PARTNERS



THE READERS  
OF  
TIME

"Let our planes be free to carry American airplanes and American goods across any country in the world—let every airport be a free port—and aviation can use its unbacked power to create more jobs, more wealth, in a positive world.

"Then, with plane service linking every U. S. city and town with all the commercially important cities in the world, aviation shall at last come into its own."

This is the market aviation thinks of when it thinks of the more than a million TIME-reading families (America's best program for planes and air travel)—and the hundreds of thousands of TIME-reading executives (whose positions in American business make them the natural national demand for any program aviation may set up). The best place to talk to these people is in TIME—for they read their favorite magazine 7 to 1 over the runner-up.

# Announcing Two Highly Developed Collins Autotune\* Transmitters

**Collins 18P-9**—Maximal power output: 200 watts phone; 300 watts CW. Frequency range: 9 to 18 mc. Ten quick-shift frequencies.

**Collins 231D-13**—Maximal power output: 2000 watts phone; 3000 watts CW. Frequency range: 2 to 18 mc. Ten quick-shift frequencies.

In design and construction, these transmitters reflect intense engineering endeavor and hard won experience in meeting the requirements of war. The most advanced laboratory refinements are combined with military ruggedness on a production-line basis!

The lessons learned since Pearl Harbor have increased the already high reset accuracy and dependability of the Collins Autotune. Any one of ten frequencies is reliably, precisely available at the flip of a dial, from a remote point. The standard models are crystal controlled, and special models are available with tunable master oscillator control.

The physical size of these transmitters has been increased, and components specially Collins re-designed, to increase safety factors throughout.

The renowned Collins pi network matches into a wide variety of single wire or vertical antennas. The 231D-13 also matches into a 600 ohm balanced transmission line from 4 to 18 mc.

Frequency-shift keying is available, making it possible to use these transmitters in printing telegraph circuits.

We will welcome inquiries and an opportunity to make recommendations for your particular application. Collins Radio Company, Cedar Rapids, Iowa.

\*The Collins Autotune is a representative mechanism which quickly shifts all tuning controls simultaneously and with extreme precision to any one of a number of pre-selected frequencies. Patents issued and pending in the U. S. A. and other countries.



IN RADIO COMMUNICATIONS, IT'S...



AVIATION, PHOENIX



## THUNDERBOLT Takes a "belly-whopper" SAFELY!

Shelby Seamless Steel Tubes are used to brace the crash skids of the P-47 Thunderbolt. On the strength of these braces largely depends the safety of both pilot and plane when a forced landing without landing gear must be made.

FOR paralyzing attacks at tree top level or for police duty in the stratosphere, the Thunderbolt serves equally well. Pilots love it because it packs a powerful punch. It flies high, fast, and far and is more heavily armed and armored than any other single-engine fighter.

In fighter-bombers, trainers and scout planes, Shelby Steel Tubing provides maximum strength in vital parts with minimum weight. Engine mounts and landing gear successfully absorb tremendous vibration from powerful motors and rough landing fields. Spar chords, wing struts and braces assist the strain of sudden maneuvering and dives—faster than 700 miles per hour.

In countless applications Shelby Seamless Steel Tubes have proved they can do the tough jobs which aviation experts. In Thunderbolts, Commandos, Flying Fortress, Liberators and dozens of other planes where the elimination of dead weight is an important consideration, seamless steel tubes have been chosen because they have a higher strength-weight ratio than any other type of construction. No matter what type of aircraft making you need, NATIONAL's Complete Aircraft Tube Service can furnish it.

**SHELBY  
SEAMLESS**  
*Aircraft  
Tubing*

**NATIONAL TUBE  
COMPANY**

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, Pacific Coast Distributors  
United States Steel Export Company, New York



NITED STATES STEEL





## A little Nickel makes landing SAFER for B-29's

No ordinary metal can curb the tremendous landing momentum of the world's mightiest warplane...the B-29.

It takes metal that does more than resist the shock, abrasive wear and galling of brake drums.

Essentially the metal must dissipate intense frictional heat from restricted surfaces. It must resist distortion and heat-checking under all kinds of adversities.

That's why experienced engineers specified an alloy containing nickel...nickel-chromium-molybdenum (high carbon) steel...for B-29 brake drums.

Centrifugally cast against a steel shell, this nickel alloy iron provides a machineable structure in the light-sections involved. The composite design gives the important combination of strength and heat-and-wear resistance.

These drums are aptly given the trade name "Centrifuse" by Centrifugal Fusing Company, a supplier of those used on large bombers. "Centrifuse" drums are also used on other types of aircraft...and on combat cars and armored vehicles.

These outstanding brake drums illustrate once more the product improvement which can be made with Nickel. An alloy containing Nickel may improve your product. We invite consultation on the use of Nickel or Nickel alloys in your equipment.



Close-up view of a section cut from a typical Centrifuse brake drum, showing heat resistance to wear and to heat-checking. Other advantages include minimum warpage and maximum soundness in the product. Range of sizes run from 8" to 20" diameter. Centrifugal Fusing Company alone has produced over 4,000,000 pounds of such castings.

THE INTERNATIONAL NICKEL COMPANY, INC. • 47 Wall Street, New York 5, N.Y.

AVIATION, February, 1944

## A FOXHOLE TENANT HAS SOMETHING TO SAY!

"Ever spend a weekend in a foxhole... No? Well... until you have, it's pretty hard to understand what those lads in "that wild blue yonder" really mean to us guys slogging along in the mud... Here's a quickie... so you'll see what I mean. Back around what the folks at home call Holiday Season, our outfit is making time towards Mr. Siegfried's line, when the weather decides to turn snow-berry... Then, a heavy pent named von Rundstedt throws the works at us, all schedules for hell's west haywire, and speaking for our cocky spearhead in particular, we dug right in fast... and just tried to stay alive..."

"In these long days... and longer nights... we were cold, hungry, miserable, and let nobody kid you... scared... piously scared... for old man despair sure clamps down when you're forced to meet it out that way..."

"...Late the third day... It seemed a year... the pea soup drifted away, the sun poked thru the



clouds... and then... man oh man... those Thunderbolts came down... Prowling tanks and cunningly hidden machine guns just went right out of business... road blocks that had held us helpless west the way of the other battalions... Helina's life began to slack off, and those of us who could, crawled out, got organized, and went into high once again. Ma, I'm an infantryman, and that's the top outfit in my book... but I gotta hand one thing to those "bums"... when it comes to putting the way over a tough spot, they've got the old time, old American steam rollers."

• REPORTS FROM ALL BATTLE-FRONTES STRESS THE VITAL CONTRIBUTIONS OF THE THUNDERBOLT TO EVERY PHASE OF COMBAT....

**REPUBLIC AVIATION CORPORATION**

Manufacturer of the Mighty Thunderbolt

Farmingdale, L. I., N. Y. • Evansville, Ind.



# HYCON

3000 p.s.i.  
Hydraulic  
Power Unit

3 1/2" diameter  
8 cylinder Pump  
Unloading Valve  
Accumulator and Reserve



A small compact unit for  
machine tools,  
hydraulic presses  
and test equipment

Quickly and easily installed  
for smooth reliable  
hydraulic operations  
up to 3000 p.s.i.

*Specifications and Engineering Data  
on Request*

**THE NEW YORK AIR BRAKE COMPANY**

*Hydraulic Division*

430 Lexington Avenue, New York 17, N. Y. Factories: Watertown, N. Y.



# NEW WELDING CONTROL



**GOOD FOR ALL 3  
SPOT  
PULSATION  
SEAM**

New CR7503-C110 welding control. Heat shows the master control dial, which can be removed for mounting on the welding machine.

Tap this switch to change the control from spot or pulsation to seam welding.

## Accurate timing • Smooth heat adjustment • Fully electronic

This control is of the synchronous-precision type, and provides the accurate repetitive timing, even with synchronous or sustained line-voltage variations, essential to highest-quality welding. This control, the most versatile of all G-E resistance-welding controls, is not only ideal for the types of work given below, but it can also be used where it is desirable to do all three types of work on one machine.

### Spot or Pulsation Welding

This control is particularly well suited for these two types of welding because of its wide timing range. It can be used in the welding of thin-gage metals where accurate timing of as few as one or two cycles may be required, in the welding of heavy-gage metals or in projection welding where pulsation welding may be required, or in special welding applications where pulsation welding may be required with a minimum heat and cool time of one or two cycles.

The timing range in spot welding is from 1 to 30 cycles.\*

In pulsation welding, heat and cool time, set independently adjustable from 1 to 30 cycles\*, and the stop-decoupling circuit is adjustable from 1 to 15 inducts— independent of heat or cool time settings. When used on a 60-cycle power supply.

See all the GEMDS you need— and keep all you buy

### Seam Welding

Good seam welding is possible with this control because the accurate timing circuit and the independent adjustment of heat and cool time (in complete-cycle stops) eliminate timing variations and transient currents. Heat and cool time are independently adjustable from 1 to 30 cycles\*.

### Heat Control on All 3

Smooth heat adjustment is provided by the phase-shift method of heat control. This eliminates the need for many heat points on the welding transformer. In addition, a voltage- or current-regulating compensator can be added by simple interconnections. Also, this welding control when equipped with a tapering attachment makes possible good results in the spot welding of thin-gage air-hardenable steels.

\*When used on a 60-cycle power supply

Send This Coupon for Your Copy of Our New Bulletin

General Electric Company, Section D645-53  
Schuylerville 2, N. Y.

Please send me a copy of your new bulletin (D645-4930). I'd like more information about this new welding control.

Name

Company

Address

**GENERAL ELECTRIC**

IN THE AIRCRAFT  
AS IN  
OTHER INDUSTRIES...

EX-CELL-O

**MACHINE TOOLS BRING  
SPEED and ACCURACY to  
PRODUCTION**

Take aircraft engines, for instance. In the turning out of these aircraft engines, Ex-Cell-O is a definite factor. Not only has Ex-Cell-O one of the country's largest precision aircraft parts divisions, but Ex-Cell-O precision machine tools are being used extensively throughout the aircraft industry to produce the many thousands of precision parts needed for aircraft engines. These parts must have a high degree of precision and finish. . . . High specifications must invariably be observed. . . . The parts must be produced as fast as possible. This is the reason why Ex-Cell-O precision standard and special machine tools have long been preferred by management and workers for production of these vital parts.

**EX-CELL-O CORPORATION**  
DETROIT 4, MICHIGAN

Illustration shows three lathe tools developed by Ex-Cell-O for use in turning both sides of aircraft flange and in turning both diameters each side. The lathe tools operated by a lathe tool holder mounted on the machine stand. A single tool requires only one set of tool adjustments. Machine tools Ex-Cell-O 1114C Precision Tools.



SPECIAL MULTIPLE WAY-TYPE PRECISION BORING MACHINES • SPECIAL MULTIPLE PRECISION GRINDING MACHINES • PRECISION THREAD GRINDING, BORING AND LAPPING MACHINES • BROACHES AND BEAD SHARPENING MACHINES • HYDRAULIC POWER UNITS • GRINDING SPINDLES • DRILL JIG BUSHING CONTINENTAL CUTTING TOOLS • TOOL GRINDERS • FUEL INJECTION EQUIPMENT • R. R. PINS AND ENDINGS • PURE-PAK PAPER MILK BOTTLE MACHINES • AIRCRAFT AND MISCELLANEOUS PRECISION PARTS



*"The time has come," the Walrus said,  
"To talk of many things:"*

*Of shoes—and ships—and sealing wax—"*

What Alice found "through the looking glass" was no more wonderful than the new world of petroleum as seen by Cities Service scientists. . . . In this true Wonderland of Research the black gold of oil serves an ever-growing list of needs. . . . Yes, it polishes SHOES . . . and powers SHIPS. . . . and SEALS preserves. . . . and does a lot of other things that hold bright promise for tomorrow.

**I**n this war, Cities Service is represented on the battlefield with everything from gasoline and lubricants to highly developed specialties, such as Cities Service Anti-Corrosive, Insecticides, Demergents, Plastics and Explosives.

And to this list we have recently added tremendous quantities of 100-octane aviation fuel—enough to send great fleets of

heavy bombers over Germany every day—as well as enough gasoline capacity to supply one-eighth of the nation's seasonal rubber demands. Such are the amazing production figures of the new Cities Service Refinery at Lake Charles, Louisiana—one of the world's largest and most modern refineries devoted to Victory!

When peace comes, you can

look to Cities Service for important new developments. For the beginnings of this company go back almost as far as the Petroleum Industry itself!

In the future as in the past, Cities Service will continue to pioneer.

Progress  
through  
Service—



Conquering Climate,  
Time and Distance

VACUATE INSTRUMENT  
HANDLE WITH CARE  
WEATHER RESISTANT

ONE of the vital tasks of today's mechanized conflict is the protection of the instruments of war, in transit and storage, against the ravages of moisture damage—rust, corrosion, mildew and mold.

Dehydrated packaging, using Protok-Seal's silica gel, successfully supplies this protection . . . this method is the result of years of Davison research in the field of silica gel.

Sealed in a moisture-vapor-proof barrier, either flexible, metal or

glass, with Protok-Seal, the perfect dehydrating agent, instruments arrive clean, factory fresh, ready for instant use. This method of packaging is simple . . . saves time . . . saves money. Protok-Seal conquers the hazards of time, climate and distance between final factory inspection and complete customer satisfaction.

For successful use in your favorite Protok-Seal's value to the non-handling method in the competitive times of peace.

\*Use U. S. Pat. 2,478,000



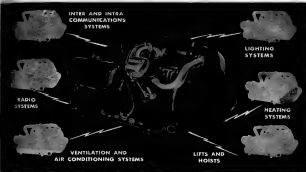
THE DAVISON CHEMICAL CORPORATION

BALTIMORE 3, MARYLAND

Canadian Distributors: Inco Agents for PROTEK-SEAL also of CANADIAN INDUSTRIES LIMITED, General Chemicals Dept.

AVIATION, February, 1946

## a compact, dependable AUXILIARY POWER UNIT for your "PORTABLE SOURCE of POWER"



### NOW READY FOR "AFTER VICTORY" INDUSTRY

Important to "after victory" industry which will demand a small size, air cooled, portable power plant, is the Andover Auxiliary gasoline-engine Power Unit . . . 30" in length—30 1/2" in width—36 1/2" in height—just under 82 pounds in weight and only 11 1/2 pounds with generator and adapter for developing electrical energy.

It develops 10 H. P. rated continuous power and 15 H. P. intermittent power. The low governed speed range of 3400 to 3200 R.P.M. insures cool running, efficient and economical operation and complete dependability.

This auxiliary power unit is now being developed for use in the following: R-29 Superfortresses and in many other military and naval planes.



If you have need for a compact, truly portable power unit—undoubtedly the Andover Auxiliary Power Unit can be adapted perfectly to your application.

Our engineers are ready to furnish you full assistance in determining the advantages of these units in your industry.

For a descriptive booklet concerning "Andover Auxiliary Power Units"—just write us—it's free for the asking.

ANDOVER MOTORS CORPORATION • ELMIRA, N. Y.

WHOLLY-OWNED SUBSIDIARY OF ANDOVER SENT AVIATION CORPORATION

AVIATION, February, 1946

"PITTSBURGH" DEVELOPMENTS IN AIRPLANE GLASS

## Bent Bullet-resisting Glass

**THE PROBLEM:** To supply a bent laminated bullet-resisting glass for use in combat airplanes where flat bullet-resisting panels are undesirable because of critical space or aerodynamic requirements.

**THE SOLUTION:** Pittsburgh Plate Glass Company developed a new manufacturing technique for the production of its Multiple Bullet-Resisting Glass in bent shapes. This involved development of all basic data on armor-piercing ammunition as used on both flat and bent bullet-resisting glass, as well as the fundamental data regarding characteristics of glass as a bullet-resisting material.

A long list of developments such as this have made Pittsburgh Plate Glass Company a recognized leader in the field of laminated safety glasses for aviation use. If you would like further technical data on any aspect of the use of safety

glass in airplane glazing, we urge you to write us on your letterhead, outlining your particular requirements. Address Pittsburgh Plate Glass Company, 2095-S Grant Building, Pittsburgh 19, Pennsylvania.

*"PITTSBURGH" stands for Quality Glass and Paint*

**PITTSBURGH PLATE GLASS COMPANY**

*Specialists in Airplane Glass*

MAKERS OF DUPLATE AND FLEXSEAL SAFETY GLASS AND OF MULTIPLE BULLET-RESISTING GLASS

AVIATION, February, 1948

## War Eagles on the Prowl...

Get Electrical Circuit  
Protection  
with  
**KLIXON AIRCRAFT  
CIRCUIT BREAKERS**

No matter what the flying mission or conditions, Klixon Aircraft Circuit Breakers help planes and crews to "come through" by protecting the electrical circuits from serious injury through enemy action or internal trouble.

Should the electrical circuit be jeopardized by a short or overload, Klixon Protectors trip-out the circuit preventing more serious damage. Once the trouble is corrected, the pilot merely pushes a button or snaps a switch and the circuit is re-established. Harmless transient shorts do not cause nuisance trips-outs.

Use Klixon circuit breakers on your planes. They are permanent protective devices which provide reliable electrical circuit protection. Bulletins giving sizes, ratings and performance characteristics are available on request.

**KLIXON**  
SPRUSE THUNDERBOLT CO., ATTLEBORO, MASS., U.S.A.

AVIATION, February, 1948



Klixon "Push-Pull" Breaker. Rating of 250 amps. "Push" button permits opening the circuit manually at the breaker for air emergency; the "pull" for remote work.

Klixon Push Breaker. Rating of 100 amps. Through 120 volts.

Klixon Push Breaker. Rating of 100 amps. Through 120 volts.

Klixon Push Breaker. Rating of 100 amps. Through 120 volts.

Klixon Switch Breaker. Rating of 100 amps. Through 120 volts.

Klixon Switch Breaker. Rating of 100 amps. Through 120 volts.

Klixon Switch Breaker. Rating of 100 amps. Through 120 volts.

Klixon Switch Breaker. Rating of 100 amps. Through 120 volts.



How to put  
Laboratory Control  
into your  
abrasive tools



ONE answer is no big gray type of Abrasive Tool from "CARBORUNDUM". Each ingredient in every product by "CARBORUNDUM" undergoes carefully supervised laboratory tests. These tests assure rigid control of the standards established for quality and product uniformity. Then, you are as-

sured that each product possesses all of the properties essential to a dependable and efficient abrasive tool. To help you choose the most efficient operating media even the most difficult conditions, the services of the "CARBORUNDUM" Abrasive Engineers are at your disposal. These men are thor-

oughly familiar with the proper application of grinding wheels, coated abrasives, abrasive grains, sticks, and "B" products. For the correct solution to your abrasive problems, consult "CARBORUNDUM" representatives. The Carborundum Company, Niagara Falls, N. Y. . . . . Distributors in Principal Cities

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**THERE IS A PRODUCT BY  
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FOR EVERY ABRASIVE APPLICATION

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# SEXTUPLE THREAT

- *Fighter*
- *Bomber*
- *Torpedo Carrier*
- *Destroyer*
- *Strafer*
- *Attacker*



Official Photo U. S. Air Force

Wrapped up in one formidable package are the lessons of five years of attack bombing. The brilliant new Douglas Invader is America's fastest, most versatile bomber. It is designed to carry such an extremely flexible selection of machine guns, cannon, bombs, and fuel that its offensive striking power is adaptable to almost any combat situation.

This sleek "war-shortener" is making its presence felt wherever the going is toughest — more power to it.

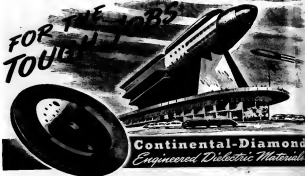
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**CHANDLER-EVANS CORPORATION**

SOUTH MERIDEN  
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A grade LE DILECTO laminated plastic insulating part used in rocket controls. Its insulating properties and dimensional accuracy must remain stable under terrific impact and vibration and regardless of temperature extremes.

THE ability of C-D DILECTO Electrical Insulation to take off a rocket can give . . . and still function perfectly . . . is good evidence that C-D DILECTO will serve well as electrical insulation in your present and future products.

C-D DILECTO is made in many standard grades to meet specific electrical, physical and thermal problems. Special grades can be developed to meet unusually exacting conditions. C-D DILECTO may be the solution to your "What Material?" problem.

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 Available in Standard Shapes, Rods and Tubes, and Parts Fabricated, Formed or Molded to Specifications.  
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 Bulletin G-2 gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.  
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**DUREX**—A Laminated Phenolic.  
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 Especially suited to U-H-F Soudable.  
**MAVEX**—Plastic Chemical Equipment, Pipes, Valves and Fittings.  
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**RAMOND**—Volcanized Glass.  
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**PORTAGRAPH**  
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"How to Reduce Costly Manual Tracing, Drawing and Copying" contains many time-saving, labor-saving ideas for the engineering office. This helpful 20-page book of practical information is available free of charge from our nearest Branch Office. Phone, write or wire for a copy.

A photoreproducing machine that reproduces exactly what it sees with no chance for human error, Portagraph is ideal for copying tracings, sketches, blueprints—anything written, printed or drawn.

Easy to operate, even for inexperienced personnel, Portagraph reduces the only time and labor required in manual copying or tracing—and eliminates subsequent checks and proofreading for accuracy.

**PHOTOGRAPHIC RECORDS DIVISION, REMINGTON RAND, BUFFALO, N. Y.**  
 AVIATION, February, 1948





## Mustangs on the Warpath

The forward element is peeling off. The other half of the squadron will fly formation during the attack, providing top cover. That's how P-51 Mustangs take to the warpath over Burma. And what a hunting ground it has

been. Hunting with everything from bazookas to 500 pound depth charges and 1,000 pound demolition bombs, Mustang pilots have forced the Jap in Burma to move furtively at night and to hide in the jungle during the day.



Like its famous namesake the P-51 Mustang is tough, hard hitting and clever.

BONDS bought these planes.  
WARRENTS helped win them.  
WASTE PAPERS helped ship them.  
GASOLINE flew them.  
WILL YOU help deliver the next squadron?

## North American Aviation Sets the Pace

PLANE THAT MAKES HEADLINES... the P-51 Mustang fighter (F-5H fighter-bomber), B-25 and P-51 Mitchell bomber, AT-6 and SN-2 Twin combat trainer. North American Aviation, Inc. Member, Aircraft War Production Council, Inc.

## OSHKOSH 4 WHEEL DRIVE



## OSHKOSH EQUIPMENT NOW AVAILABLE to Highway Departments and Airports



WITHOUT slowing up our deliveries to the armed forces, we are authorized to produce a limited number of trucks for essential civilian use. Snow removal units are now being delivered to State and County Highway Departments and to Airports.

With its twenty-seven years of four-wheel drive engineering, Oshkosh equipment provides efficient power, rugged durability and economical operation for snow removal, maintenance and heavy construction work.

Write for descriptive literature

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SERVICE STATIONS AT CONVENIENT POINTS THROUGHOUT THE U. S.

**OSHKOSH MOTOR TRUCK INC., OSHKOSH, WIS.**  
CABLE ADDRESS: "OSHMOTOR" OSHKOSH

## Only 2 quick steps to set Explosive Rivets ...and it's a one-man job



1. Insert rivet in hole.

2. Apply heated iron to rivet head.

**FOR BLIND RIVETING**... definitely! But, in addition, wherever there's a job that's hard to reach, Du Pont Explosive Rivets may save time and reduce costs.

Today, aircraft manufacturers are using Explosive Rivets on many jobs formerly finished with conventional rivets. Spots that are hard to get at... places where design, intricate wiring or bulky instruments interfere with backing bars... awkward locations inside the fuselage, wings and stabilizers... these and many more are "natural" for Explosive Rivets.

Get complete information. Write for helpful material giving all the details. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington, Delaware.



**Flush-fit holes are not necessary.** Explosive Rivets have a charge extending the full length of the shank (above). When fired (right) the entire shank expands... completely fills the hole and provides a strong, tight joint. The barrel-shaped blind head locks the rivet accurately in place...



**DU PONT  
EXPLOSIVE RIVETS**

*the only one-piece blind fastener*

ANOTHER MASS-PRECISION ASSEMBLY BUILT BY NICHOLS



### LUBRICATING THE TURBOSUPERCHARGER

If you could look in on a turbosupercharger in flight, you would marvel at its performance. Rotate an 18" shaft revolving at 22,000 RPM while exposed to plus 1500" from the engine's exhaust at one end and to the subatmosphere's minus 67" at the other. Consider the problem of lubricating the turbosupercharger's bearings under such challenging conditions.

That's the job for the self-contained, double-unit pump developed and built by W. B. Nichols and Sons on an interchangeable parts and assembly basis.

To meet both performance and cost requirements large-scale production of this self-contained simplified design, Nichols engineers blueprinted a pump that had a simple seal, no ball bearings, only three shaft diameters and two shoulders. Mass-production techniques followed through with "split-tool" accuracy in each component part and avoided costly, step-by-step inspection. Despite the close fit, all parts are assembled without protrusions.

The same ingenuity for precision manufacture on a mass-production basis has solved other equally difficult problems for over forty years. These unique facilities have been developed for producing the "hard" parts. They may be your answer for working out that post-war product. Let "Accurate" Nichols help you see it through.

W. B. NICHOLS & SONS, 48 WORCESTER AVENUE, WALTHAM 24, MASS.

"Accurate" *Nichols*



PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

AVIATION, February, 1946

AVIATION, February, 1946

**BOMBS for TOKYO**

**AIDED BY WESTERN Felt**

America's Superfortresses deal deadly destruction to Japanese war plants because felt—in many forms—rides hostile skies with them. In greater safety and comfort—crew members do a better job, thanks to felt which seals "pressurized" cabins, guards precision instruments against vibration, deadens motor sound, insulates against cold . . . and serves as gaskets, washers, lubricating wicks, etc.

For many purposes only felt can meet specifications that demand flexibility, resistance, compressibility, resistance to water, oils, heat and age—plus sound

deadening, heat or cold insulation of other properties. Western Felt is suitable to a wide variety of uses . . . It is processed from wool-soft to rock-hard—as may be finished to insulatingly dielectric.

A Western Felt Works engineer will gladly tell you the full story of felt as in the modern plane and its myriad uses it might be applied to your product present or potential. Write us today!

**WESTERN FELT WORKS**  
4035-4117 Ogden Ave., Chicago 25, Ill.  
Branch Offices in All Principal Cities

**WESTERN Felt**  
Largest Independent Manufacturer and  
Distributors of Wool, Hair and Felt



Asphalt Products Division, Processors of Synthetic Rubber and Plastics: Sheets, Extrudates and Molded Parts

## POINTING THE WAY IN AVIATION COMMUNICATIONS

DESIGNING



ENGINEERING



MANUFACTURING



• United Cinephone Corporation spent its pre-war years successfully solving manufacturers' problems by the application of Electronic Devices . . . We are now meeting the demands of the armed services and have extended our facilities many times.

This experience coupled with increased facilities will continue to function in pointing the way to the solution of postwar aircraft, electronic and communication problems.

Address all inquiries to  
Applications Engineering Department

We now invite inquiries from manufacturers in connection with the development and production of all types of electronic and communication equipment for the aviation industry.



**MODEL 857 AIRCRAFT TRANSCEIVER**  
A typical military product of  
UNITED CINEPHONE CORPORATION

**UNITED CINEPHONE CORPORATION**  
1201 N. WASHINGTON AVENUE, CHICAGO 25, ILL.

# Chicago AUTOMATIC RIVETING

INCREASES OUTPUT

## Ten to Twenty Times!

MODEL 79  
Multiple rivet  
center with ad-  
justable riveting  
action to set riv-  
ets close together  
or widely apart.  
Use for Don, Group  
and Elastic Stop  
Nut Plates.

By changing from hand feeding and insertion of the rivet to Chicago Automatic Rivet Setting, many manu-  
facturers conservatively estimate they have multiplied  
each riveter's output ten times. Actually, in hundreds  
of sub-assembly operations, the use of Chicago  
Automatic Riveting Machines and Tubular Rivet  
has increased the production of individual workers  
twenty times! And so simply see these manpow-  
er-saving machines operated that the usual schooling  
of inexperienced operators is unnecessary.

The speed of Chicago Automatic Riveting Machines  
lies in their completely automatic operation. Preci-  
sion tubular or aircraft rivets are fed, inserted and  
clipped with each release of the foot pedal. The

machines are easily adjusted in a few  
minutes to handle different sizes of  
Rivets. And whether it is a single or  
multiple type Chicago Rivet Setting  
Machine, whether it has a 45-deg  
throat, or a 6-inch throat, it clinches  
grooves and eyelets, and inserts drive  
screws as efficiently as it sets rivets.

Fully approved by Army and Navy  
engineers, far faster in production,  
effective both in saving vital man-  
power and cutting production costs,  
it is little wonder that the aircraft  
industry is depending more and more  
on Chicago Automatic Riveting.

MODEL 140  
with interchangeable  
rivet holder and  
nutting assembly  
also Feeds, Inserts,  
Clips and Don Nut  
sets and Grooves.



Feeder is pre-  
specially fed directly  
inserted or driven,  
completing the work.



With faster both  
ends of a Don or  
shoulder girdle with  
one stroke. Also  
set in one opera-  
tion the two rivets  
necessary to hold  
an elastic stop nut  
plate, or anchor  
nut in place.

# Chicago Rivet

CHICAGO RIVET & MACHINE CO.

3616 West Jackson Boulevard, Bellwood, Illinois Chicago Suburb

# Our Post-War Policy in one word\*

# "AVIATION!"



The Doak organization was born in aviation  
of aviation long before Pearl Harbor. All of  
our key personnel have at least 15 years expe-  
rience in aircraft production. We believe in  
aviation. It is the most dynamic force in trans-  
portation today.

We, therefore, are not thinking or planning  
in the usual conversion or "reconversion"  
terms. We believe that the industry is going  
to need more than airplane manufacturers in  
the competitive era; that it will need men with  
specialized skills and specialized machinery.

The Doak plant is a self-contained metal work-  
ing factory, with complete processing depart-  
ments. We entirely manufacture in our own  
plant complete parts and assemblies which  
now fly on all fighting fronts with our airmen.

*E. B. Doak*

E. B. DOAK, President

DOAK AIRCRAFT CO., INC.  
TORRANCE, CALIFORNIA

WE DO NOT INTEND TO MANUFACTURE REFRIGERATORS, VACUUM  
CLEANERS, BOWEGATE, CAN OPENERS OR EGG BEATERS.

# AIRCRAFT WIRE PRINTER

DESIGNED BY  
AIRCRAFT ENGINEERS

TO MEET ARMY-NAVY  
REQUIREMENTS

Developed by Tool Design Engineers of Glenn L. Martin Company and built by York Electric, manufacturers of standard Wire and Cable Printers. Our Wire and Cable Printers now in operation in leading wire manufacturing plants.

Specialists in manufacture of Wire and Cable printing devices for years, Wire Printer now offered the aircraft industry incorporates the engineering experience thus gained.

## NOT A TOY—NOT AN EXPERIMENT

It was natural for York Electric to make the first practical hot stamp wire printer for aircraft wire identification used at Glenn L. Martin plant that automatically prints miles of wire.

"Easily meets the Wright Field wire specification 3231DA, amendment No. 4, Nov. 11, 1942

A thoroughly tested Wire Printing Machine. Wire immersed in gasoline and oil for one hundred hours without damage, passing Army and Navy tests.

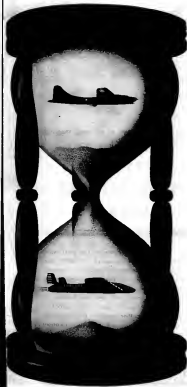
Equipped with movable hand cut beams, or steel and laundry type, new codes and symbols are instantly available.

The code wire marker you will eventually for Avoid disappointing experiments with other makeshifts.

Thermostatic controlled heated type, prints desirable identification on No. 22 to No. 9 wires.

This rugged York Electric Wire Printer built to give years of service. "Bugs" eliminated. Aircraft industry now presented with wire printer engineeringly correct.

**YORK ELECTRIC TOOL COMPANY**  
52 SO. DUKE ST., YORK, PA.



## WILCO facilities Expanded to Meet Wartime Needs!

But Postwar Industry will be  
the ultimate gainer from the  
many new WILCO products  
and developments

As the Hourglass indicates . . . at the closing of peace, the skill and experience gained in the development and application of new WILCO products and techniques will mean much to automotive, electrical appliance and many other types of manufacturing customers.

Though now chiefly applied to the war effort, these new WILCO developments are destined to play a vital role in the post-war industrial "comeback" as they are now playing in scores of wartime applications.

Thermostatic Bimetallics, Electrical Contacts, and Precision Metal Bimetallic Products are such important factors in the precision performance of ships, planes, tanks, guns, and various instruments of the Army and Navy that the H. A. Wilson Company has found it necessary to enlarge its facilities and develop these important new products and techniques.

In the postwar period no company will be better equipped to meet individual requirements for Thermostatic Bimetallics and Electrical Contacts on any desired scale than the H. A. Wilson Company, pioneers in this field.

WILCO PRODUCTS ARE: Contacts—Silver, Platinum, Tungsten, Alloy, Sintered Powder Metal, Thermostatic Bimetal—High and Low Temperature with very high temperature deflection rates. Precision Metal Collector Rings for rotating controls. Silver Clad Steel—for bearings, shafts, reflectors. Inlaid Wire—Silver on Steel, Copper, Invar, or other combinations required. Silver Clad Steel. Rolled Gold Plate. Special Materials.

THE H. A. WILSON COMPANY  
105 Chestnut Street, Newark 5, New Jersey



Thermostatic—Electrical Contacts  
Precision Metal Bimetallic Products



Radio Antenna Systems



Taper Poles  
Thermal Bottles - Quivers  
Ski Poles - Masts and Spars



PLYMOLD CORPORATION Lawrence, Mass.



Aircraft, radio, furniture, in fact most industrial fields can take advantage of PLYTUBE's characteristics of high mechanical strength — corrosion resistance — high dielectric strength — wide variety of sizes and easy work ability in improving their own product in design, construction and manufacture.

PLYTUBE is water proof — rot proof — splinter proof — weather proof — flame resistant and meets U. S. Army and Navy specifications AN-G8 or AN-NN-P311b.

Write today and we will be glad to help you adapt PLYTUBE to your specific requirements.



A peacetime plane that was "built to order"  
FOR THOUSANDS OF AMERICANS



Easy to Fly... Easy to Own...

Thousands have admired the popular Bellanca Aircraft Quon, and still the returns roll in! They show increasingly that The Bellanca Cruisair, as produced since the war, approached the ideal peacetime personal plane that America's flying public has in mind.

The leading sources indicate that the flying public wants a three to four place low wing monoplane with retractable landing gear, equipped with a 125 to 150 hp air-cooled opposed engine and gross weight in the 1500-2000 lb. bracket — all features which the Bellanca engineering organization had anticipated and incorporated in the pre-war Quon. The Cruisair's top speed of 150 mph, cruising speed of 130 mph, and landing speed in the 50-60 mph range come within the performance preferences expressed by the majority. Typical Bellanca efficiency provided extensive economy of

operation—22 miles per gallon of fuel, as better than two miles per minute cruising speed.

The Quon returns are voluntary—they give a pattern of the ideal specifications and requirements of the airplane which will most closely approach the desires and wishes of the majority! These results indicate that The Bellanca Cruisair was practically "built to order" for the thousands who are now placing their post-war flying.

WRITE NOW FOR THE QUIZ!

You still have time to enter the Bellanca Aircraft Quiz and register your views on the many airplane features listed. Just send your name and address—an obligation—and we'll send you a printed copy of the Quon prospectus... Bellanca Aircraft Corporation, New Castle, Delaware, Dept. B K.

The BELLANCA Cruisair



## Needle Bearings Provide Anti-Friction Ease in Manual Controls of Vought Corsair



These are typical  
Needle Bearing appli-  
cations in Corsair con-  
trol assemblies.



Fast, smooth operation is a "must" in the design of aircraft controls. To assure complete anti-friction ease at such points, designers of the famous Vought Corsair specified the use of Torrington Needle Bearings—the only anti-friction bearings found to meet space, weight and operating requirements.

Yes, too, will find where space, weight, load capacity, stability and the ease of anti-friction operation are important factors, the application of Torrington Needle Bearings frequently offers the best solution to design problems.

Investigate for yourself how the anti-friction advantages of Torrington Needle Bearings can be of assistance in your product planning. Details will be found in Catalog No. 20-A. Send for your copy today.

**THE TORRINGTON COMPANY**  
TORRINGTON, CONN. SOUTH BEND 21, IND.

New York Boston Philadelphia Dallas Cleveland Seattle  
Chicago San Francisco Los Angeles Toronto London, England

## TORRINGTON NEEDLE BEARINGS



# BARBER-COLMAN

## MICRO CONTROLS

### For Aircraft Applications

Barber-Colman MICRO Control equipment is specially designed and built for aircraft service. Note light weight, small size, and high torque indicated by brief specifications here. Note also the clean lines and compact construction, characteristic of modern aircraft equipment. Barber-Colman Controls have proved their ability to perform accurately, reliably, and efficiently in leading lines of aircraft service now in service. With many conversion jobs coming up, they are worth considering now in order to provide accurate control of CABIN TEMPERATURE . . . ANTICLING TEMPERATURE . . . CARBURATOR AIR TEMPERATURE . . . CARBURATOR MIXTURE . . . CARBURATOR THROTTLE. Write today for further information on the units shown here and others Barber-Colman Controls designed for aircraft service. Look for Barber-Colman equipment in the air-lanes of tomorrow!



TYPE FIVE GAUGE GAS THERMOSTAT  
Fuel Gauge built with and with 1/2 in. 1/2 in.  
Pressure, 30/20 - 30/20 - 30/20



TYPE FIVE GAUGE CARBURATOR AIR TEMPERATURE  
Gauge built with and with 1/2 in. 1/2 in.  
Pressure, 30/20 - 30/20 - 30/20



TYPE FIVE GAUGE CARBURATOR MIXTURE  
Gauge built with and with 1/2 in. 1/2 in.  
Pressure, 30/20 - 30/20 - 30/20



TYPE FIVE CONTROL MOTOR  
Motor built with and with 1/2 in. 1/2 in.  
Pressure, 30/20 - 30/20 - 30/20



TYPE FIVE CONTROL MOTOR  
Motor built with and with 1/2 in. 1/2 in.  
Pressure, 30/20 - 30/20 - 30/20

# BARBER-COLMAN

COMPANY

ROCKFORD - ILLINOIS

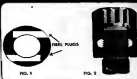
PRECISION

UNBRAKO

SAFETY

INTERNAL 100° FLUSH HEAD  
WRENCHING BOLT SOCKET BOLT  
(National Aeronautical Standard)

INTERNAL WRENCHING  
LOCK NUT



Our INTERNAL WRENCHING BOLT (A) and 100° FLUSH-HEAD SOCKET BOLT (B) fully meet the high degree of precision demanded by the aviation industry. They are made to tolerances so extremely close as to be practicable only by our long and extensive experience in precision work. Designed expressly by and for the aviation industry, these bolts have the famous "Unbrako" qualities of strength and accuracy, while due to their internal wrenching features they facilitate compact design, thereby saving material, weight and space.

The "UNBRAKO" INTERNAL WRENCHING LOCK NUT is a safety nut for primary connections in aircraft—officially approved. Qualifying through "tensileproofing" with ample load-carrying capacity, the "Unbrako" Lock Nut achieves an absolutely dependable locking grip by means of two vulcanized fibre plugs (Fig. 1) inserted through the body of the nut. Fig. 2 shows how these plugs contact four flanks of the bolt, gripping it firmly.

Heat-treated to a high degree of Rockwell hardness, the "Unbrako" can be used almost indefinitely before the torque falls below the Wright Field minimum.

OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 344

BRANCHES — BOSTON — DETROIT — INDIANAPOLIS — CHICAGO — ST. LOUIS — SAN FRANCISCO

AVIATION, February, 1941



## IT'S REPLACEABLE JOE!

The valve can be fixed in a few seconds. That's good news to men responsible for "keeping 'em rolling and fighting!"

Suppose G.I. Joe's valve was the Schrader Valve of 50 odd years ago without today's removable, replaceable parts! He would have to dismount his tire and tube and vulcanize an entire new valve on his tube to replace it!

Compare this with the modern Tire Valve Equipment. In the event of any possible damage of tire valve seating parts, he can make a complete change of cap and core in less than a minute. Think of what that means to the mobility of our troop movements which today counts on split second timing! One standard size of cap and core is interchangeable in the standard valve in any pneumatic tire on any vehicle—the standard, lightest, lightest type of

set-in stock—an advantage which supply experts, in and out of the Armed Forces in all parts of the world, appreciate.

As time goes on, the parts of any valve wear. Abuse, grit and age cause any valve to lose its 100% efficiency. The experience of many years, plus billion after billions of miles—most other work, of actual performance on trucks, cars, cycles, have proved this to be true. But due to foresight of the tire, automotive and valve industries, the tire valve can be restored to its original efficiency by merely inserting a new core and applying the standard cap. The Schrader Valve Cap is guaranteed airtight up to 250 lbs. pressure.

A view of "How to Pressure Roadable Tire Valves" an explanation of the Comparative Air Loss System, as described in the Office of Defense Transportation Bulletin, is available from Schrader upon request.



**Schrader**  
CONTROLS THE AIR

SCHRADER'S SON, Division of Sevvil Manufacturing Company, Incorporated, BROOKLYN 17, NEW YORK

AVIATION, February, 1941



# ALLIED

Buy Where We Build

## ... An Ideal of Quality reflected in a Name

For years the divisions of Allied Products Corporation have held proudly to an ideal of quality. Through two wars its craftsmen have produced the finest in precise production made.

Because of this ideal, Allied has become a standard source of supply for many mass production industries. Now, because of wartime expansion, Allied is equipped to serve more manufacturers than ever before. Anticipate your postwar requirements and start now to profit by Allied's years of experience and exceptional facilities. A good beginning is to check your

supply problems with Allied. Send blueprints for estimates or write today.

"WE ARE ALLIED PRODUCT" . . . Allied Products Corporation has divisions, Richard Brothers and Vroom-Peterson, in Detroit and Milwaukee, Michigan, make cold forged parts, bushings and precision ground parts, cap screws, sheet metal and the largest in the smallest, B.S. interchangeable plastic parts, structural plastic molds, pipe and flanges and quality production tools.

**ALLIED PRODUCTS CORPORATION**

Department 18, 4616 Lewiston Avenue, Detroit 5, Michigan

AVIATION, February, 1945

## "Aero-Seal" HOSE CLAMPS

### STAINLESS STEEL

Where service conditions require highest corrosion resistance, these stainless-steel clamps should be used. They incorporate all the basic superior features of Aero-Seal design plus some distinctive engineering advantages such as non-welded saddle, greater strength, greater flexibility, and slightly less weight than their low steel counterparts. They will now be available in all standard sizes from  $\frac{1}{2}$ " through  $4\frac{1}{4}$ ". Let us know your needs now, so we can advise you as accurately as possible on the scheduling of future deliveries.

- HIGH STRENGTH
- UNIFORM PERIPHERAL TIGHTENING
- NO LEAKAGE UNDER HIGH PRESSURES
- SELF-LOCKING, NO LOCK WIRE NEEDED
- CAN BE PUT ON HOSE IN PLACE
- NO LOOSE PARTS
- CAN BE RE-USED
- WILL NOT DISTORT OR COLLAPSE THIN-WALL TUBING
- COMPACT DESIGN
- FULL RANGE OF SIZES
- EXTRA LONG TAKE-UP

### CARBON STEEL

Substantial heat-treated carbon steels, finished in high-grade cadmium plating for rust resistance, go into the making of these Aero-Seal Hose Clamps. Millions of these clamps are in strenuous active service and have achieved the widest acceptance under the strict requirements of Army-Navy Specification AN-FFC 406a. Manufacturing facilities for all sizes in the full range are now functioning independently so that orders can be handled for near-future delivery or to stock. We urge that you advise us of your future requirements now so that we can take care of your needs as promptly as possible.

AIRCRAFT STANDARD PARTS CO.  
718 NINETEENTH AVE. ROCKFORD, ILLINOIS



WE ORIGINATED the AERO-SEAL Hose Clamp design and thus offer you the background of longest experience in the manufacture of this new and better type of hose clamp.

# OHMITE NEW AN3155 (AN-R-14)

## Aircraft Rheostats



with  
NEW  
IMPROVED  
Control  
Protection

**OHMITE**  
*Resistors*  
USED IN AIRCRAFT



Ohmite Rheostats have long been standard on aircraft. Today, these new AN3155 units provide new improved control protection and other new features. They assure smooth, close, dependable control under every service condition of heat, cold, humidity, altitude, shock and vibration.

Made in 25 watt and 50 watt sizes—linear or taper wire-wound—in various resistances—with "off-position" as required by the specification. Totally enclosed in a unique, corrosion-resisting metal enclosure. Light in weight than the allowable weight specified. Write for details.

**OHMITE MANUFACTURING COMPANY**  
4945 FLOURNOY STREET • CHICAGO 44, ILLINOIS

Be Right with **OHMITE**  
RHEOSTATS • RESISTORS • TAP SWITCHES

### IT PACKS A BIG PUNCH

It's small but busy—concentrated power for dependable performance on many types of jobs requiring maximum power per ounce of weight. 1/32th to 1/300th H.P. From 3000 to 30,000 R. P. M. 6 to 115 volts AC-DC. It's engineered and precision-built to your exact specifications. What type of small fractional H.P. motor do you need? Send specifications and quantity wanted. Write today.

*Small Motors, Inc.*  
23 BOSTON BLVD. CHICAGO 23, ILLINOIS

Types of motor: 1/200 to 1/300 H.P. 6 to 115 volts AC-DC. 3000 to 30,000 R. P. M. 1/32th to 1/300th H.P. per ounce of weight.

Design • Engineering • Production

### Special

Hard-to-work flat head rivets are easily driven with one hand when the new engineered Aero special tool is used. Caps coined to assure uniform dimensional accuracy with a maximum radius of only .010."

Danger of rejects caused by improperly fitting turned tools is eliminated. The new Aero set will not flatten, distort or otherwise weaken flat head rivets, allowing for positive maintenance of rigid engineering standards.

Plants using flush sets to drive AN-442 rivets may substantially increase production and eliminate rejections caused by skin abrasions due to slippage of flush sets. Cost per rivet driven will go down and the strength of the rivet joint will not be impaired when the Aero tool is substituted for incorrect flush sets.

Write now on firm letterhead for full engineering information on the performance of these new rivet sets ... ask for Catalog Page No. 25.

Coined AN-442 sets are available in both straight and offset at no increase in catalog prices. Order by number shown above, specifying AN-442 cup in size and length desired.

## AERO TOOL CO.

BURBANK • CALIFORNIA



reduce non-productive  
ground time



CLARK TRACTOR

12111 CLARK BUILDING, U.S.A.

Products of CLARK - TRANSMISSIONS - ELECTRIC STEEL CASTINGS -  
AXLES FOR TRUCKS AND BUSES - AXLE HOUSINGS - BLIND RIVETS -  
INDUSTRIAL TRUCKS AND TRACTORS - HIGH-SPEED DRILLS AND REAMERS -  
METAL SPOKE WHEELS - GEARS AND FORGINGS - RAILWAY TRUCKS

# VISION for VICTORY

with a  
**LIBERTY  
AIRCRAFT  
MIRROR**

The pilots of thousands of the fighter planes, now in action over our widely scattered battle lines, are getting a perfect image of things behind them, without strain or fatigue, by means of Liberty Aircraft Mirrors.

Liberty Aircraft Mirrors are of first surface mirrors, and at no moment on their glass face. They give the pilot a clean, well defined image without distortion, heat, or glare.

Each fighter plane equipped with a Liberty Mirror has a mirror ball to meet the specific requirements of that plane. Thus the pilot always has one plane to another or continuously good vision at all times in all planes.

All Liberty Mirrors are now built only for War service, but the same battle tested vision device will be available to all types of military, transport or private.

**LIBERTY  
MIRROR DIVISION**

LIBBY-OWENS-FORD GLASS COMPANY  
BRACKENRIDGE  
PENNSYLVANIA



For more information  
contact Liberty's Sales Representative  
in your area. He will be glad to send you a  
copy of our literature.

## DEPENDABLE McDONALD HOSE NOZZLES



Photo 291—McDonald  
1 1/2" Hose Nozzle  
(Patented)

Photo 292—McDonald  
2000-2500 P.S.I.  
Nozzle 1 1/2" and 1 1/4"  
(Patented)

Photo 293—McDonald  
P.A.R. Hose Nozzle  
1" and 1 1/4"

McDonald, one of the largest manufacturers in its field, is a thoroughly reliable source for hose nozzles, among others, that require, versatility and safety. High, medium and low pressure, high speed rotary pumps and other products designed to add speed and safety to the movement and movement of oil and gasoline.

Y. MCDONALD MFG. CO.  
DUBUQUE, IOWA

## Fluid Power Systems

If you have mechanical operations to get done with efficiency and economy, consider Fluid Power.

It is the modern way to transmit power from its source to its job—without shafts, gears, belts or levers.

It moves wherever you want it to go through tubes, and is controlled by valves.

Your Fluid Power system will deliver sure and dependable performance, under all conditions, if it is

*Engineered by*  
**PARKER**

### THE VITAL LINK

In Fluid Power is the Circuit. It goes around corners and into tight places. It must be proof against leak, shock and vibration, and must be pressure-tight.

Parker brings twenty years of experience to the engineering of this Vital Link. We build the valves and fittings, and the tools to handle them.

This specialized "know-how" is yours to command.

You'll find it worth-while to talk with a Parker Fluid Power Engineer. Write to The Parker Appliance Company, 17325 Euclid Ave., Cleveland 12, O.

**PARKER**

## THIS DUGAS SCREEN



### SHIELDS FIRE-FIGHTERS

Dense clouds of fire-killing dry chemical create a real "heat-shielding screen" for the operator whenever a DUGAS Fire Extinguisher, charged with PLUS-FIFTY DUGAS Dry Chemical, is used to beat down a blaze.

All DUGAS Fire Extinguishers—large and small—are designed with fire-fighter protection as well as

fire-fighting effectiveness in mind—a big reason why workers who may have to be fire-fighters feel more confident when they see DUGAS equipment close at hand.



Non-toxic, non-corrosive and non-oxidative. Approved by Underwriters' Laboratories and Factory Mutual Laboratories.

ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN  
DUGAS DIVISION

# 3 1/2 ounces

WITH TWELVE CONTACTS

GENERAL CONTROL COMPANY'S NEW  
MODEL MCM  
"MIDGET"



LEVER  
SWITCH

The "Midget" is designed especially for electronic and communication circuits in aircraft, and for other light duty applications. It is a "Midget" in both size and weight... it is very precise in space and weight, yet it is ruggedly constructed that it will stand severe use.

The contact possibilities are unlimited... contact assemblies can be removed from the frame by removing a single bolt... all parts are non-corrosive... has easy, positive roller action, regardless of number or arrangement of contacts in and out of the switch... a single bolt only is required for panel mounting... it may be provided to prevent turning in the mounting and... rated from 5 to 10 amps, 125 volts A.C.

The standard "Midget" has all three positions as shown in diagram, or can be supplied with two positions (no neutral).



GENERAL  
CONTROL COMPANY

1207 SOLDIER FIELD ROAD  
BOSTON 24, MASS.

AVIATION, February, 1945

# PRECISION

— AS VITAL IN WAR AS IN PEACE



In every theater of war South Bend Lathes are holding to their pre-war traditions for dependable precision. In the mobile machine shops of our mechanized forces they duplicate factory tolerances on intricate parts needed for emergency repairs on guns, tanks, trucks and other essential equipment. On board many of the Navy's fighting ships, where high precision is an absolute requirement, they are also depended upon for maintenance and repair of mechanical equipment. In the repair bases of the Air Forces they play an equally important part in keeping planes in service. Sometimes small South Bend Lathes are even flown to remote locations for making quick repairs on grounded planes.

In all classes of war service these lathes are doing fine precision work—not only with the armed forces but also in industry where dependable accuracy is as vital as speed and versatility in meeting war's urgent production schedules.

When civilian production is resumed South Bend precision will again prove as indispensable to peace-time industry as it is now for exacting war work. Embodying the improvements developed to meet war production requirements, South Bend Engine Lathes and Toolroom Lathes will be available, also the South Bend Precision Turret Lathes having 36" and 17" collet capacity.

NEW CATALOG  
NOW READY  
Write For It

Efficient in full color—this new 64-page catalog shows all types of South Bend Lathes, Engine Lathes and Toolroom Lathes with 36", 24", 18", 16", 12", and 8" swing. Precision Turret Lathes with 36" and 17" collet capacity. Shows complete line of accessories and attachments for use with these lathes. Ask for Catalog No. 100-D.

Lathe Builders for 38 Years

**SOUTH BEND LATHE WORKS**

552 EAST MADISON STREET • SOUTH BEND 35, INDIANA

AVIATION, February, 1945

*Super Fortress*



*Super Transport*



*Super Powered!*

U. S. Super-Positive Piston Rings

designed and machined to constant perfection, serve wherever air might be needed to turn the tide of battle. Bombs and war freight of unbelievable coverage are carried by giant planes that literally control the world.

Based on a traditional policy of research and everything adhering to the great exacting manufacturing controls, U. S. Super-Positive will, when peace comes, continue to be the accepted standard of Aviation quality.



YOUR BONDS WILL SHORTEN THE WAR—BUY MORE

For Best Conditions  
Having Peak Performance

Use U.S. Super Positives

U. S. HAMMERED PISTON RING CO., INC.  
STERLING, NEW JERSEY, U. S. A.



"SINGLE-  
RELEASE"  
Harness

UNITED NATIONS' FLYERS  
are using it for  
SAFER LANDINGS

A one-hand turn and a tap on the single front disk instantly releases the harness . . . leaving the flyer entirely free. Accidental release is impossible before disk is "set" for action.

All United Nations' Air Forces for years have used IRVIN as standard equipment . . . and now the Irvin "Single-Release" harness is acknowledged as superior for all landings. IRVIN, as always, leads in Safety.



Used in Air

Used in Water

Used in Life

IRVING AIR CHUTE CO., Inc.

3840 40th ST. N.E. DEERFIELD, N.Y. 11742  
Complete Factories in Buffalo, N. Y., Glendale, Calif.,  
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AVIATION, February 1947



Have You A Control Problem  
As Tough As This?

17 FEET OF CONTROL  
270° OF BENDS  
50 LB. OPERATING LOAD  
ELECTRICALLY ACTUATED

50  
Pounds

LET SIMMONDS ANALYZE  
YOUR CONTROL PROBLEM

- 1. Does your control system require, or have
- 2. What does the control separate?
- 3. What Compensator (Elec.) Transfer (Elec.)
- 4. VIBRATION CHARACTERISTICS
- 5. TEMPERATURE CONDITIONS
- 6. HEIGHT SYSTEM
- 7. RANGE OR AID MOVEMENT

Make sketches of the end view of the control. The major graph paper and indicate end of control.



Simmonds EQUIPMENT FIRM WITH  
EVERY TYPE OF AERIAL INSTRUMENT

Address: Engine Controls — Push-Pull Controls  
Aircraft Flight or Electronic Accessories  
Weather Instruments — Conventional Instruments  
Repairs and Clinic of Specialized Design

TOUGH has typical of the remote control problems successfully solved by the Simmonds precision-built Push-Pull Controls is the one described above. Designed to meet the exacting conditions of aircraft operations, more than half a million Simmonds Controls are today flying on every Allied battlefield. Increasingly, Simmonds Controls are also being specified for installation on tanks, submarines, automobiles and industrial units to replace cumbersome and inefficient or pulley and cable systems, and error pneumatic lines.

Basically, the Simmonds precision-built control consists of a series of "steel heads" strong on a cable and enclosed in either a rigid or a flexible tubing. The "heads" give the push and the cable the pull — hence the push-pull of two-way control. Straightline travel can be transformed into rotary motion by means of the Radius Unit; a variety of other frictions and accessories are available. Under difficult conditions involving loads and demands around bend insensitiveness, or surviving vibration or relative motion between two units, and wherever the minimum in position remote mechanical control is required, Simmonds Controls are proving their commanding merit.

Let Simmonds engineers help solve your remote control problems. For a free and constructive analysis, send data concerning your requirements, as suggested in the panel at left, to the nearest Simmonds office.

push and the cable the pull — hence the push-pull of two-way control. Straightline travel can be transformed into rotary motion by means of the Radius Unit; a variety of other frictions and accessories are available. Under difficult conditions involving loads and demands around bend insensitiveness, or surviving vibration or relative motion between two units, and wherever the minimum in position remote mechanical control is required, Simmonds Controls are proving their commanding merit.

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AVIATION, February, 1942

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AVIATION, February, 1942

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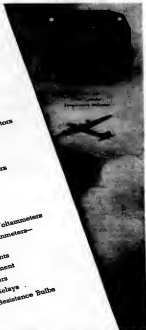
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AVIATION DIVISION  
THE IMPERIAL BRASS  
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AVIATION, February

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ATGOS, February, 1945

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ESTABLISHED, February, 1945

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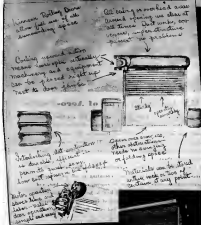
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(Continued from page 112)

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2. These lathes are designed and these lathe men are experienced in building Logan lathes.
3. Logan lathes are built in a new, modern factory equipped with the best machines and skilled workmen.
4. A management policy, showing quality of production rather than volume, that has produced a personnel of loyal workers.



Further answers to this matter will give you more insight into why it will pay to own one Logan lathe or get the Logan lathe before you buy a lathe.



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